AUTO THROTTLE - DESCRIPTION AND OPERATION

1. Description

A. The auto throttle system provides the means for automatically controlling the engine throttles during approach/landing procedures. The system functions as an independent system utilizing a reference signal output from a speed command computer. Although the speed command computer is not a part of the auto throttle control system, it is required for system operation.

B. The system is comprised of an auto throttle lever, a computer with control and interlock circuits, linear accelerometer, servo drive unit (servo drive and gear box), throttle levers drive clutch, engage switch, disengage solenoid, quick-disconnect buttons, and an auto throttle off warning light (see Figures 1 and 1A).

C. Computer

(1) The auto throttle computer contains the electronic circuits required to process the reference signal from the speed command computer and generate the electrical output to command servo drive movement. The computer also provides minor loop stabilization, circuit interlock functions, throttle logic circuit functions, and warning light functions.

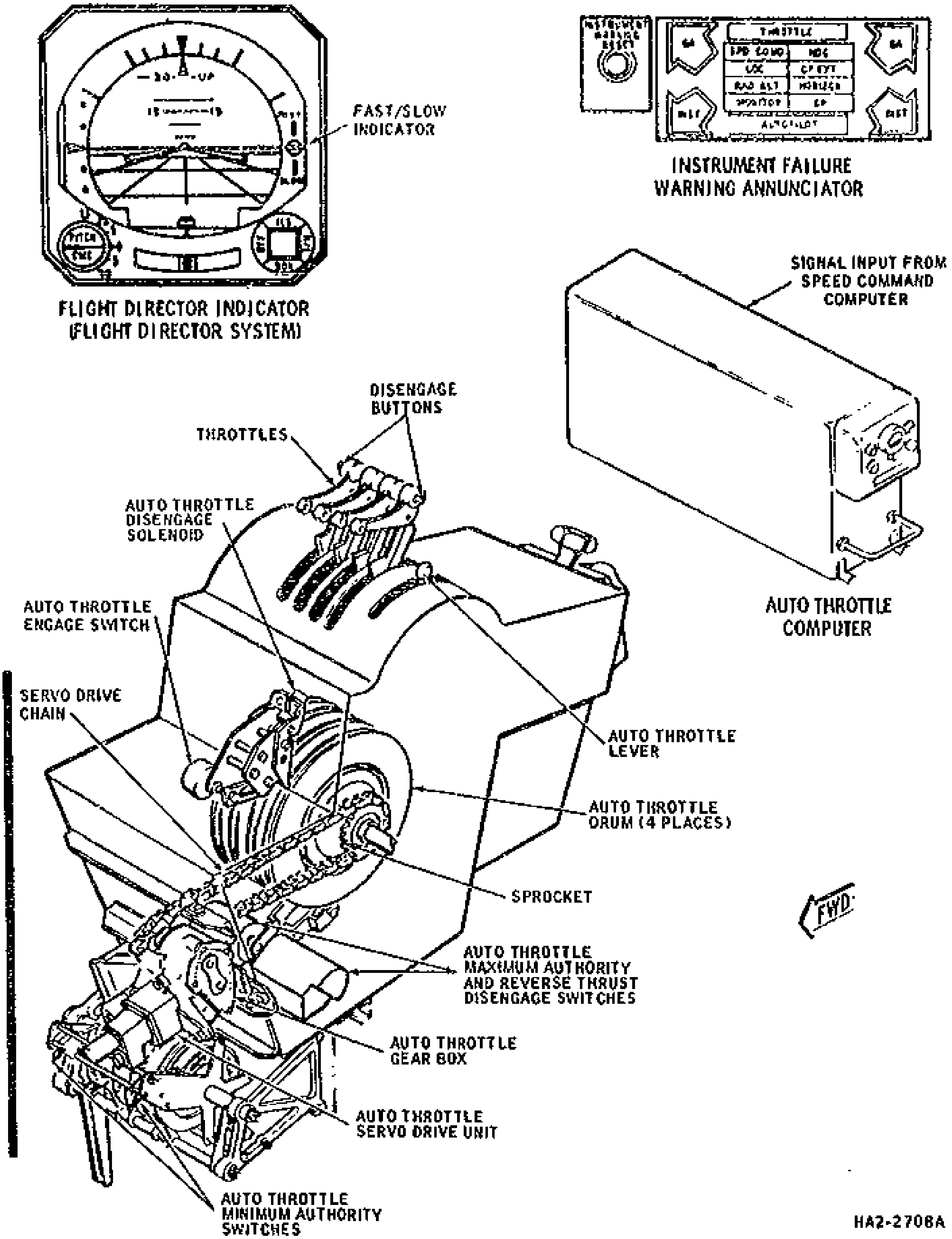
(2) The control and interlock circuits monitor servo drive command signals for system operation within safe maneuver boundaries. Throttle position sensing, through the maximum and minimum authority switches, is used to prevent the servo system from driving the throttles into regions of excessively high or low engine thrust operation.

(3) Monitoring within the computer includes comparison of command signal input with tachometer feedback. System engage logic is interrupted when any malfunction is detected, thus disengaging the system.

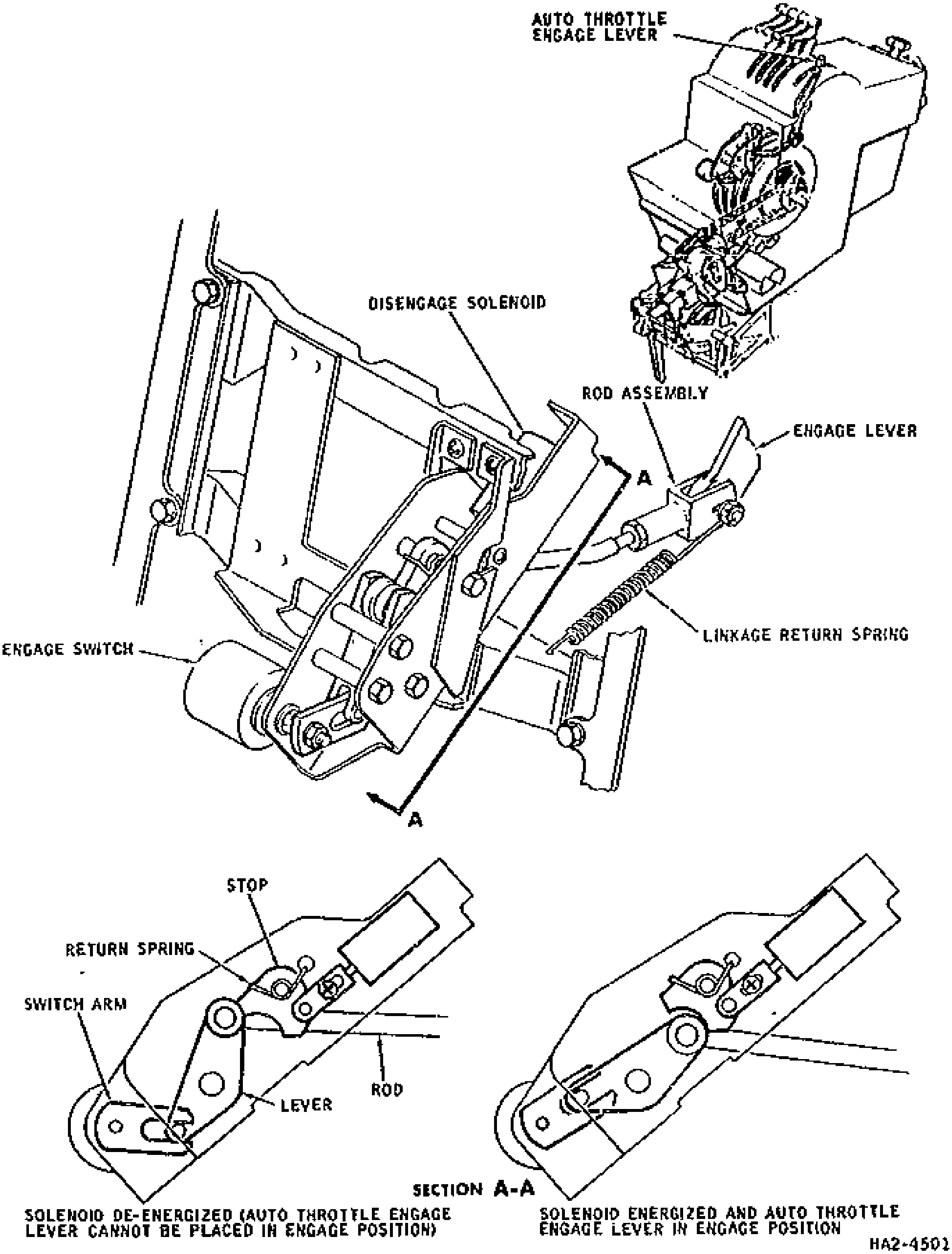
(4) The front panel self-test assembly includes a meter and selector switch for testing all system components.

D. Servo Drive System

(1) The servo drive system includes the servo drive and the airplane gearpack unit located at the forward end of the pilot's control pedestal in the flight compartment. The servo drive includes motor, rate generator, and reduction gears. The airplane gearpack includes a reduction gear train and chain sprocket.



Auto Throttle Control System
Figure 1



Auto Throttle Lever Linkage
Figure 1A

(2) The speed and direction of rotation of the servo motor is proportional to the command signal from the servo amplifier in the auto throttle computer. Servo motor speed is reduced through reduction gears and here coupled to the airplane gear pack by means of a splined shaft. Drive speed is further reduced in the gear pack and the output torque at the sprocket drives a chain to position the throttle levers. The servo system drives the throttles at a 8 degrees/second at maximum signal input.

E. Throttle Levers Drive Clutch (See Figure 2.)

(1) The throttle levers drive clutch couples the servo system torque to the engine throttle levers. The clutch assembly can be manually overpowered with a force no greater than ordinarily required for throttle operation with auto throttle system disengaged. At the same time the holding power of the clutch is sufficient to be insensitive to system friction gradients, vibration, or breakway forces.

(2) There are four sprag clutch units, one for each throttle lever. Eight manual input driver fingers are mechanically connected to each throttle lever and positioned 90 degrees apart between four sets of double sprag linked to the output sheave as shown in Section A-A Note that for each direction of rotation, one of each pair of sprags will jam against the servo input race and the other will slide.

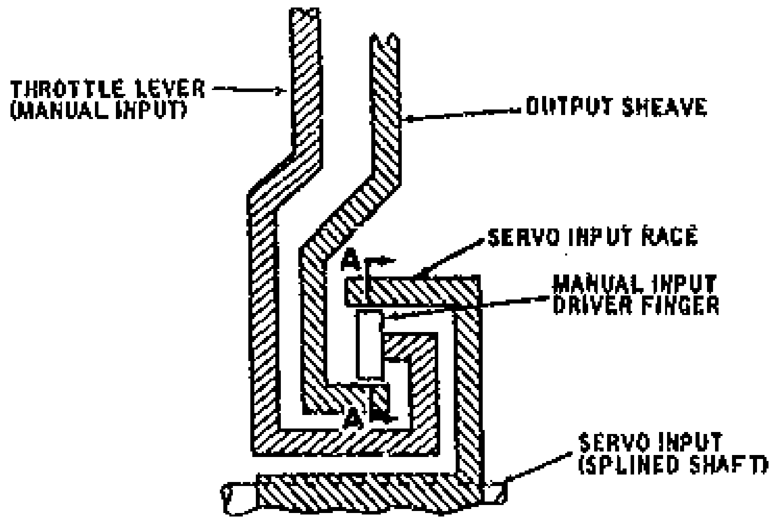
(3) The auto throttle servo system drives the servo input race. As the race moves, the leading sprag in each pair jams and causes the output sheave to rotate. The output sheave is connected to a cable running aft to its respective engine.

(4) Manual operation and override of the servo drive system are identical because in both instances the manual input driver fingers release the sprags from the servo input race. When the throttle lever is moved, the driver finger pushes the jam-side sprag of each pair away from the servo input race as shown by dashed lines. Positive driving control is now made between the driver finger and the sprag at point X and direct force is applied to the output sheave.

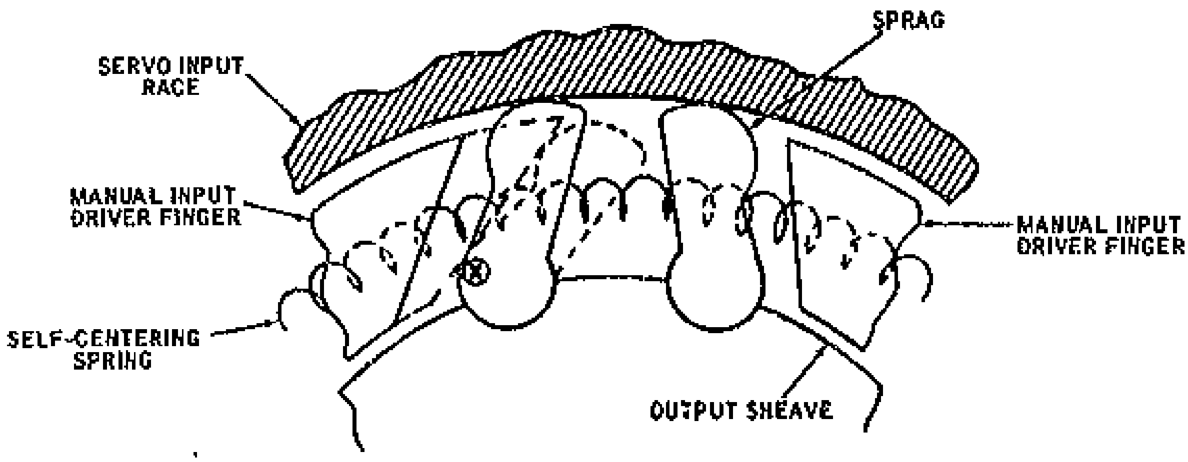
(5) The servo drive system and gear train provide sufficient holding torque against the sprag clutch during manual operation to prevent any creeping of throttle settings.

F. Engage Lever

(1) The auto throttle lever, located adjacent to the throttle levers, provides the means for engaging/disengaging the auto throttle system. The lever is mechanically connected to the auto throttle engage switch. Unless engage logic circuits are satisfied, the lever cannot be moved from the disengage position.



CUTAWAY VIEW OF CLUTCH - UPPER HALF



SECTION A-A
SPRAG DRIVER SET

HA2-2659

Throttle Clutch Unit
Figure 2

G. Engage Switch

(1) The auto throttle engage switch, located at the forward end of the pilot's control pedestal, closes the circuit between the auto throttle computer and the servo motor. Switch actuation/deactuation is controlled by mechanical linkages connected to the auto throttle lever.

H. Disengage Solenoid

(1) The auto throttle disengage solenoid, located adjacent to the engage switch, is electrically controlled by 28 vdc supplied from the computer, through an interlock circuit. When the solenoid is energized, the auto throttle lever and linkage can be moved to place the engage switch in the engage position. If the electrical circuit to the solenoid is opened while the auto throttle system is engaged, the solenoid deenergizes causing the linkage to move and place the switch and the lever in the disengage position.

I. Authority Switches

(1) Maximum and minimum authority switches (within the pilot's control pedestal) are interlocked through the computer to prevent the servo drive from moving the throttles into an engine thrust region that would be abnormal or unsafe during landing/approach conditions. However, the throttle levers can be manually moved throughout their entire range (aft mechanical stop to forward mechanical stop) without disengaging the auto throttle system. When released, the throttles will move to a thrust setting to satisfy the error command from the speed command system. Each of the 2 maximum authority switches is controlled by the corresponding inboard throttle levers. The 2 minimum authority switches are controlled by the corresponding outboard throttle lever.

J. Reverse Thrust Disengage Switches

(1) Each of the 2 reverse thrust disengage switches is a part of the disengage solenoid interlock circuit and is controlled by a corresponding reverse thrust lever. When either reverse thrust lever (No. 2 or No. 3) is moved into the reverse thrust range, the solenoid deenergizes causing the engage lever linkage to move the lever and the engage switch to the disengage position.

K. Quick Disconnect Buttons

(1) Auto throttle release buttons are located on the outboard side of number one and number four throttle lever handles. For manual takeover (as for example, during go around) the system is overpowered and released by one hand motion.

L. Auto Throttle Off Warning

(1) A red auto throttle off warning lamp is located in each master failure warning annunciator. The lights will come on whenever the auto throttle is disengaged by any means. The lights can be reset by pressing the monitor reset button located adjacent to each failure annunciator.

M. Fast/Slow Indication

(1) A fast/slow indicator, located in the flight director indicator, presents visual indication of programed airspeed in relation to attitude and trim during approach/landing procedures.

NOTE: The primary purpose of the fast/slow indicator is for monitoring speed command system operation.

(2) Proper auto throttle system operation will adjust the throttles during flight so the pointer on the indicator will stay in the center position of the fast/slow scale.

2. Operation

A. The auto throttle operates from signals from the speed command system. Engine power settings are automatically adjusted to maintain an optimum speed during landing approach conditions. Auto throttle can be engaged only if the speed command system is in the approach mode and all system interlocks are satisfied.

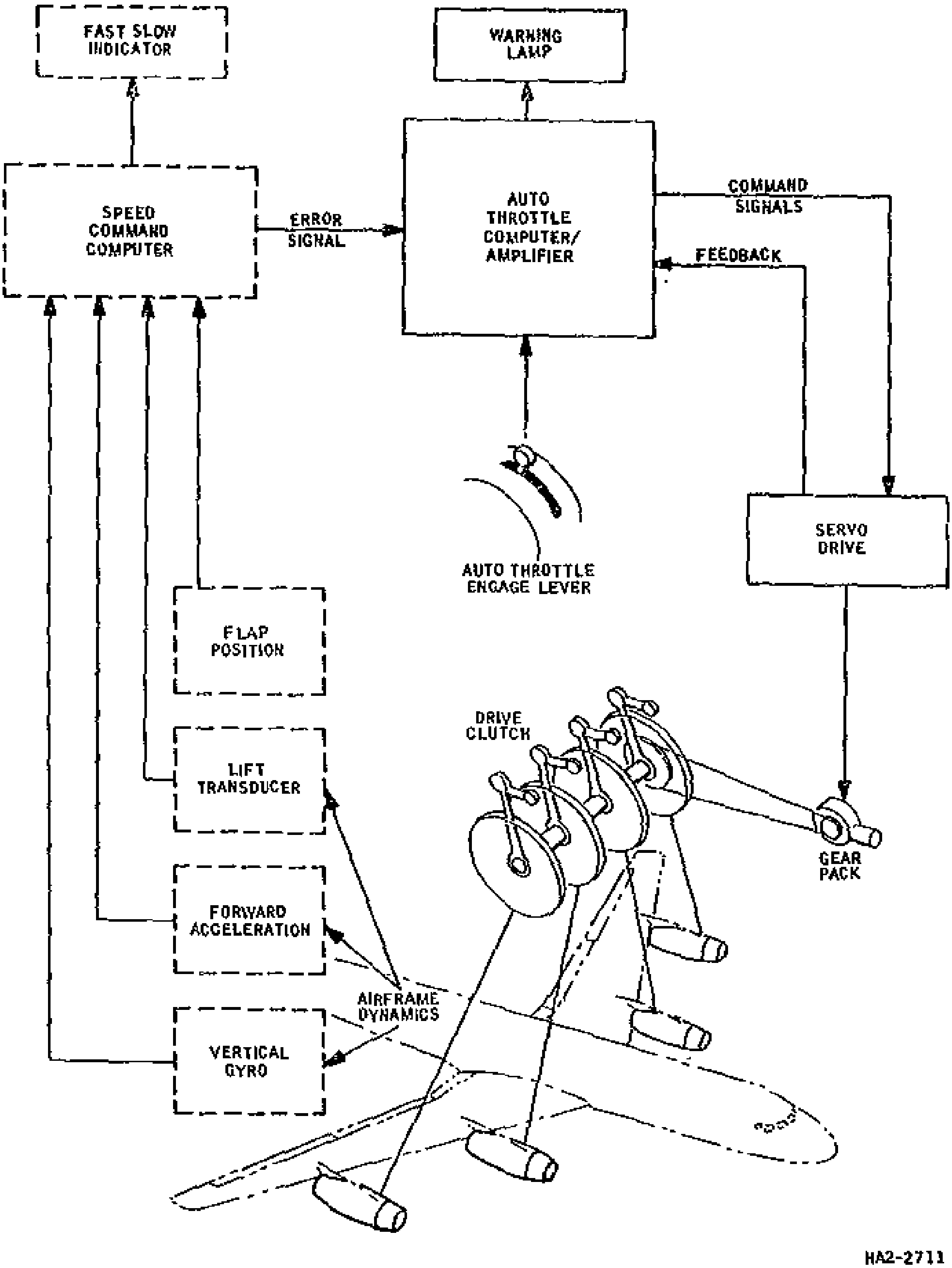
B. During the approach mode, the speed command system senses wing lift, pitch and pitch rate, flap position, and forward acceleration. These components of airplane dynamics are used to compute an optimum approach speed for the existing trim, weight, and attitude of the airplane. Any error from this speed reference is displayed on the fast-slow indicator (an integral part of the flight director indicator. This same reference/error signal is fed to the auto throttle computer/amplifier where it is used to generate the electrical output to command servo drive movement. (See Figure 3.)

C. The auto throttle control system is automatically disengaged when any one of the following conditions occur:

(1) The monitor in the computer detects a malfunction.

(2) Speed command system is placed in other than approach mode.

(3) Either auto throttle quick disconnect button is pressed.



Auto Throttle System
Figure 3

(4) Movement of auto throttle lever to disengage position.

(5) Movement of either No. 2 or No. 3 reverse thrust lever into reverse thrust range.

(6) Rotation of any anti-skid wheel speed transducer.

AUTO THROTTLE - DESCRIPTION AND OPERATION

1. Description

A. The auto throttle system provides the means for automatically controlling the throttle levers to maintain a selected indicated airspeed during approach/landing procedures. The system is independent of the autopilot system and is comprised of an auto throttle lever, a computer with control and interlock circuits, linear accelerometer, servo drive unit, (servo drive and gear box), throttle levers drive clutch, engage switch, disengage solenoid, quick-disconnect buttons, and an auto throttle off warning light (see Figures 1 and 1A).

B. Auto Throttle Computer

(1) The auto throttle computer contains the electronic circuits required to process the input signals and generate the electrical output to command servo drive movement. Signal inputs to the computer include airspeed error, longitudinal acceleration, elevator movement, and pitch attitude. These signals, processed in the auto throttle computer, operate the servo system to provide precise airspeed control with a minimum of throttle lever activity.

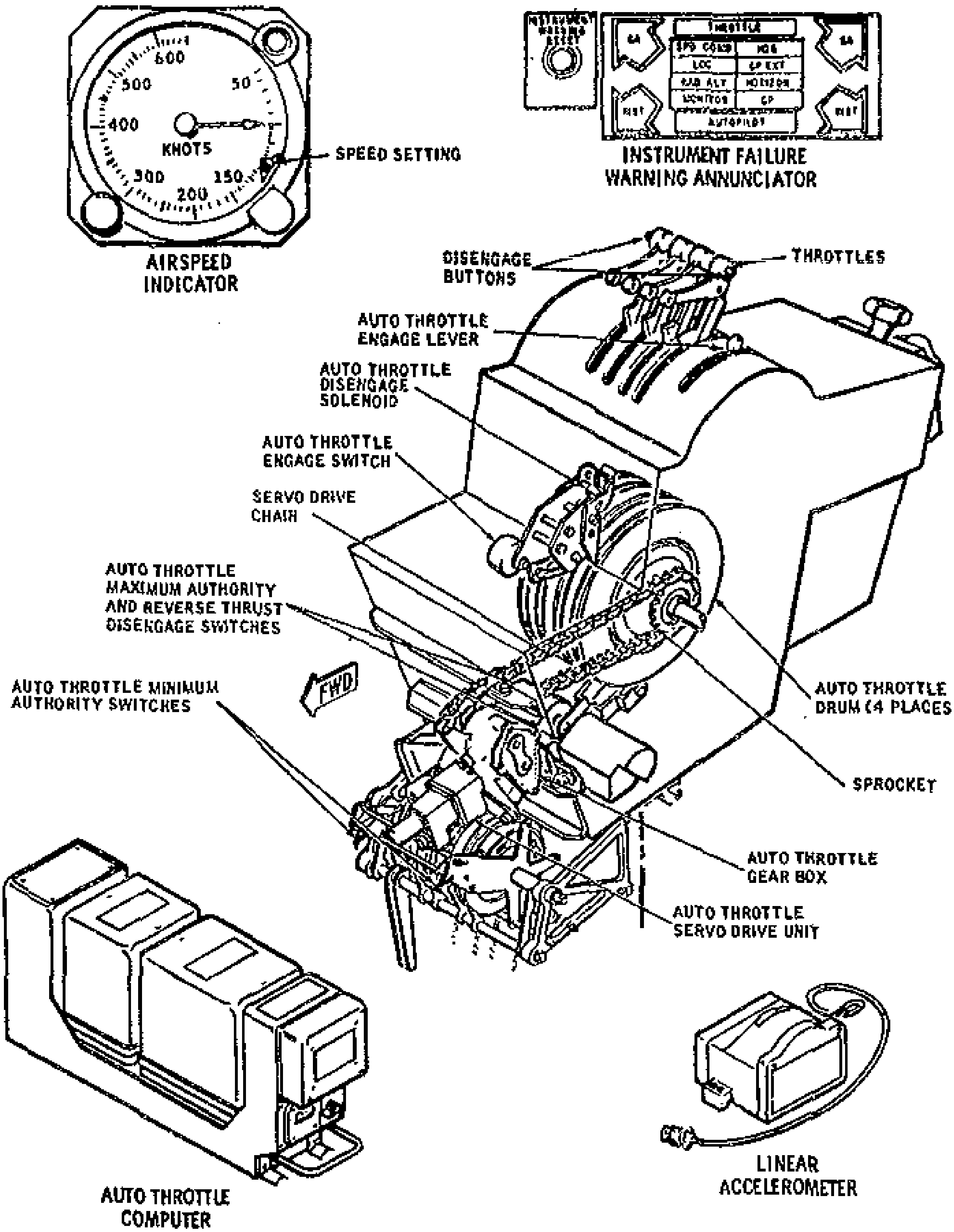
(2) The control and interlock circuits monitor servo drive command signals for system operation within safe maneuver boundaries. Throttle position sensing, through the maximum and minimum authority switches installed in the throttle level cam package, is used to prevent the servo system from driving the throttles into regions of excessively high or low engine thrust operation.

(3) Monitoring within the computer includes comparison of command signal input with tachometer feedback. System engage logic is interrupted when any malfunction is detected, thus disengaging the system.

(4) The front panel self-test assembly includes a meter and selector switch for testing of system components.

C. Linear Accelerometer

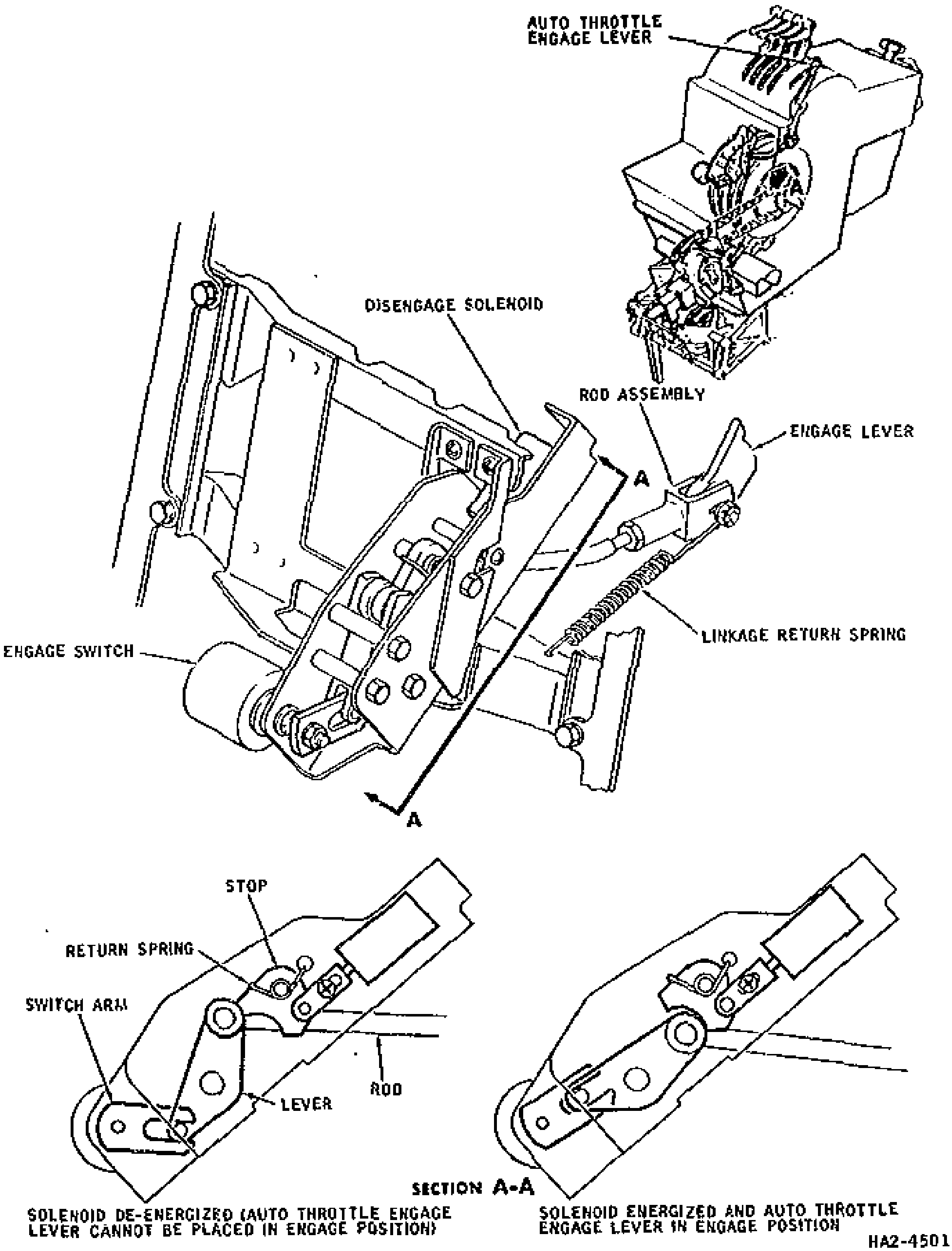
(1) The linear accelerometer is an electromechanical device that translates longitudinal acceleration into electrical signals. The unit is a hermetically sealed, fluid-damped-type transducer comprised of an E-pickoff transformer and a suspended armature. The E-shaped core of the transformer has the excitation winding on the center leg, and the signal output on the two outer legs. The signal output windings are differentially connected to produce a null (zero output) under static (no forward acceleration) conditions.



HA2-2612A

Auto Throttle System Components
Figure 1

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Auto Throttle Lever Linkage
Figure 1A

(2) Self-test coils, actuated by the self-test switch on the auto throttle computer, provide for remote checking of the accelerometer when installed in the airplane.

D. Servo Drive System

(1) The servo drive system includes the servo drive and the airplane gearpack unit located at the forware end of the pilot's control pedestal in the flight compartment. The servo drive includes motor, rate generator, and reduction gears. The airplane gearpack includes a reduction gear train and chain sprocket.

(2) The speed and direction of rotation of the servo motor is proportional to the command signal from the servo amplifier in the auto throttle computer. Servo motor speed is reduced through reduction gears and coupled to the airplane gearpack by means of a splined shaft. Drive speed is further reduced in the gearpack and the output torque at the sprocket drives a chain to position the throttle levers. The servo system drives the throttles at 8 degrees/second at maximum signal input.

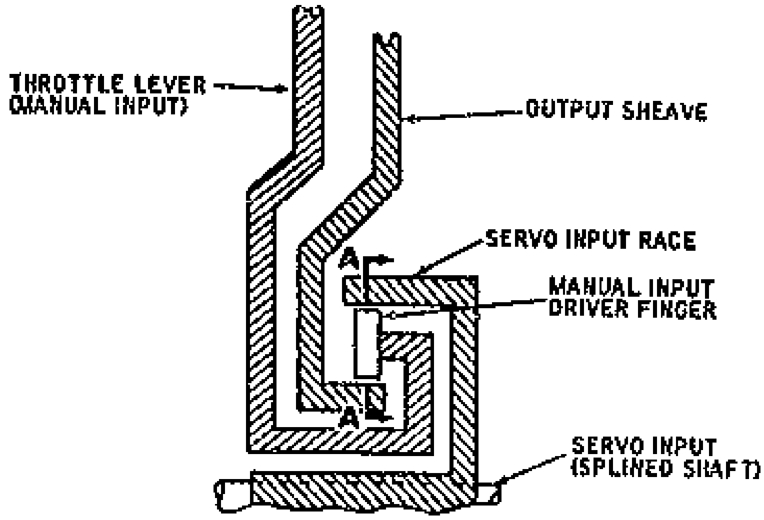
E. Throttle Levers Drive Clutch (See Figure 2.)

(1) The throttle levers drive clutch couples the servo system torque to the engine throttle levers. The clutch assembly can be manually overpowered with a force no greater than ordinarily required for throttle operation with auto throttle system disengaged. At the same time the holding power of the clutch is sufficient to be insensitive to system friction gradients, vibration, or breakaway forces.

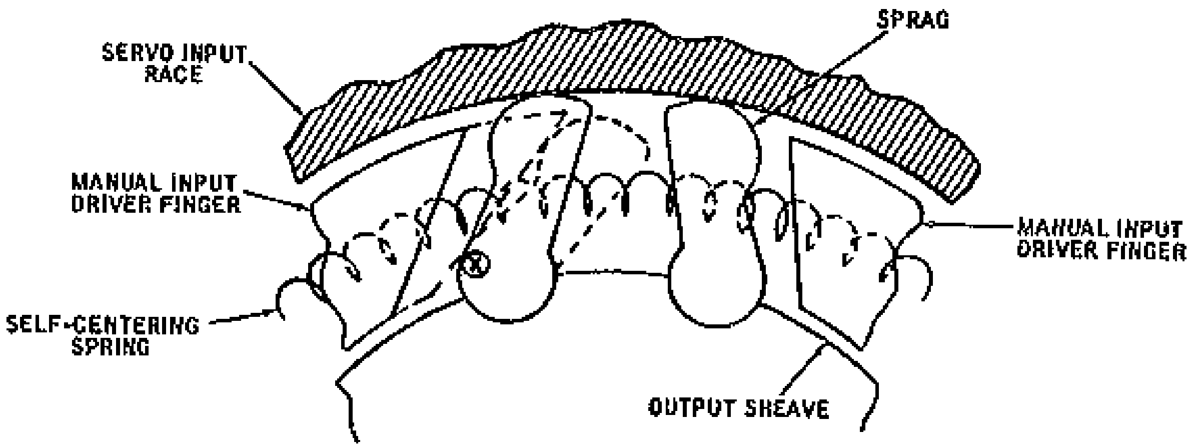
(2) There are four sprag clutch units, one for each throttle lever. Eight manual input driver fingers are mechanically connected to each throttle lever and positioned between four sets of double sprags linked to the output sheave as shown in Section A-A. Note that for each direction of rotation, one of each pair of sprags will jam against the servo input race and the other will slide.

(3) The auto throttle servo system drives the servo input race. As the race moves, the leading sprag in each pair jams and causes the output sheave to rotate. The output sheave is connected to a cable running aft to its respective engine.

(4) Manual operation and overpower of the servo drive system are identical because in both instances the manual input driver fingers release the sprags from the servo input race. When the throttle lever is moved, the driver finger pushes the jam-side sprag of each pair away from the servo input race as shown by dashed lines. Positive driving control is now made between the driver finger and the sprag at point X and direct force is applied to the output sheave.



CUTAWAY VIEW OF CLUTCH - UPPER HALF



SECTION A-A
SPRAG DRIVER SET

HA2-2659

Throttle Clutch Unit
Figure 2

(5) The servo drive system and gear train provide sufficient holding torque against the sprag clutch during manual operation to prevent any creeping of throttle settings.

F. Engage Lever

(1) The auto throttle lever, located adjacent to the throttle levers, provide the means for engaging/disengaging the auto throttle system. The lever is mechanically connected to the auto throttle engage switch. Unless engage logic circuits are satisfied, the lever cannot be moved from the disengage position.

G. Engage Switch

(1) The auto throttle engage switch, located at the forward end of the pilot's control pedestal, closes the circuit between the auto throttle computer and the servo motor. Switch actuation/deactuation is controlled by mechanical linkages connected to the auto throttle lever.

H. Disengage Solenoid

(1) The auto throttle disengage solenoid, located adjacent to the engage switch, is electrically controlled by 28 vdc supplied from the computer, through an interlock circuit. When the solenoid is energized, the auto throttle lever and linkage can be moved to place the engage switch in the engage position. If the electrical circuit to the solenoid is opened while the auto throttle system is engaged, the solenoid deenergizes causing the linkage to move and place the switch and the lever in the disengage position.

I. Authority Switches

(1) Maximum and minimum authority switches (within the pilot's control pedestal) are interlocked through the computer to prevent the servo drive from moving the throttles into an engine thrust region that would be abnormal or unsafe during landing/approach conditions. However, the throttle levers can be manually moved throughout their entire range (aft mechanical stop to forward mechanical stop) without disengaging the auto throttle system. When released, the throttles will move to a thrust setting to satisfy the error command from the speed command system. Each of the 2 maximum authority switches is controlled by the corresponding inboard throttle levers. The 2 minimum authority switches are controlled by the corresponding outboard throttle lever.

J. Reverse Thrust Disengage Switches

(1) Each of the 2 reverse thrust disengage switches is a part of the disengage solenoid interlock circuit and is controlled by a corresponding reverse thrust lever. When either reverse thrust lever (No. 2 or No. 3) is moved into the reverse thrust range, the solenoid deenergizes causing the engage lever linkage to move the lever and the engage switch to the disengage position.

K. Quick-Disconnect Buttons

(1) Auto throttle release buttons are located on the outboard side of number one and number four throttle lever handles. For manual take-over (as for example, during go-around) the system is overpowered and released by one hand motion.

L. Auto Throttle Off Warning

(1) A red auto throttle off warning lamp is located in each master failure warning annunciator. The lights will come on whenever the auto throttle is disengaged by any means. The lights can be reset by pressing the monitor reset button located adjacent to each failure annunciator.

M. Auto Throttle Calibrator

(1) The auto throttle calibrator permits plug-in calibration of the auto throttle computer to meet the requirements of different airplane types and series. It also controls the amplitude relationship of electronic signals at various points within the auto throttle computer system. Thus the auto throttle calibrator controls the speed of throttle change in response to a system input. Selection of a particular auto throttle calibrator is determined by airplane aero-dynamics and operating procedures.

(2) The auto throttle calibrator plugs into the front mounted electrical connector of the auto throttle computer (located in the radio rack in the flight compartment). The calibrator must be installed before the system can be tested or put into operation.

2. System Operation

A. Desired indicated airspeed is manually selected on the airspeed indicator by means of the set knob. An error signal (difference between existing and selected airspeed) is fed into the auto throttle computer. This signal is summed with a forward acceleration signal received from the linear accelerometer and a pitch anticipation signal from the elevator position sensor. The final combination is filtered to remove gust induced noise. A pitch reference signal is used to remove any pitch component from the accelerometer signal. (See Figure 3.)

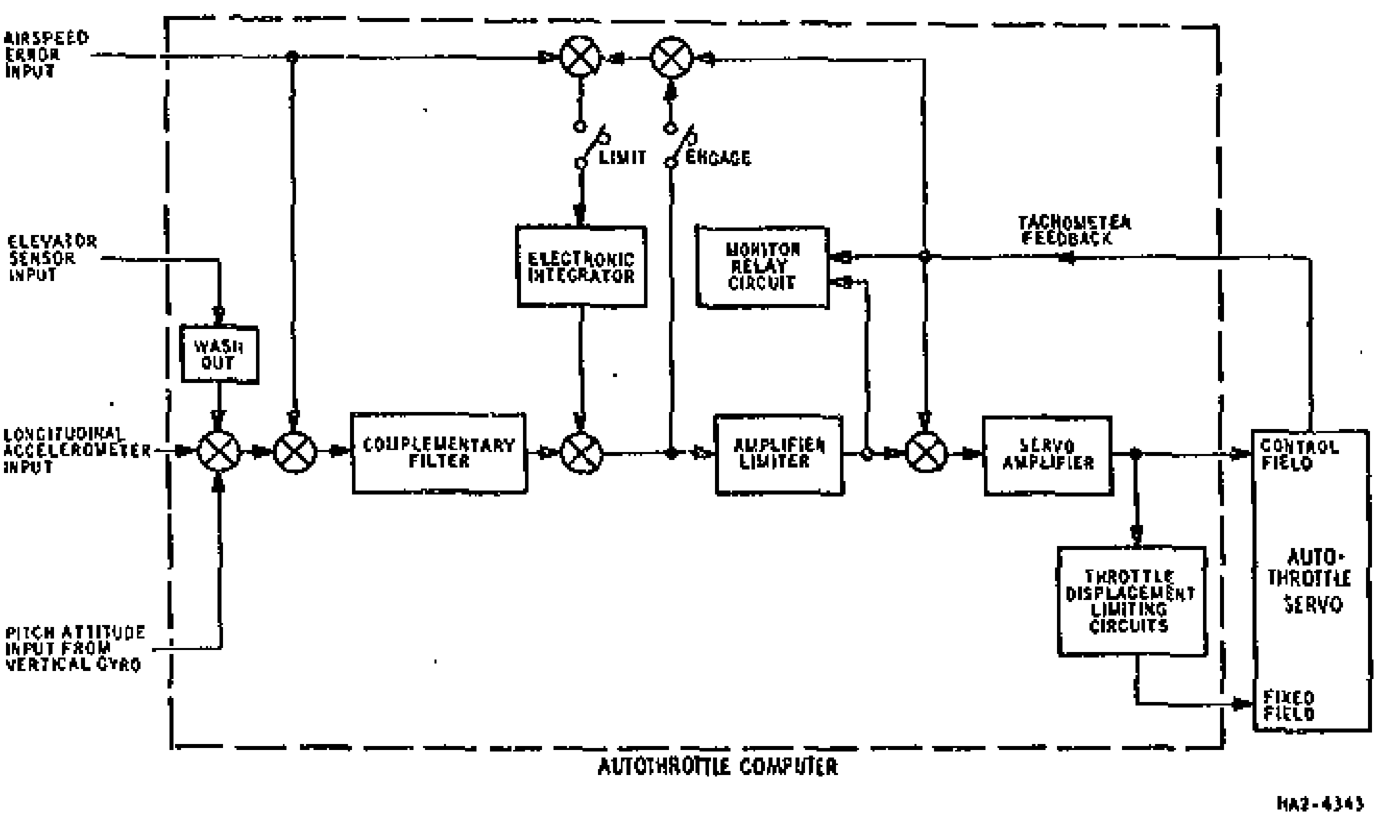
B. The airspeed error signal is processed through an electronic integrator circuit and summed with the complementary filter output to eliminate stand-off errors due to changes in steady state thrust requirements. A servo tachometer feedback signal, derived from a precision tachometer on the system servo motor, is also sent through the integrator to derive throttle position feedback information.

C. The integrator is also used to synchronize the system in the disengaged mode. The airspeed error signal is disconnected during synchronization to prevent the integrator from wiping out any present airspeed error.

D. With all system engage interlocks satisfied, the auto throttle lever can be moved to and will hold in the engage position. This closes the circuits (through the engage switch) to allow the servo amplifier to provide power to the control field of the ac servo motor in the form of 400-cps variable width rectangular pulses. Output voltage is a function of pulse width which is controlled by signal level.

E. Throttle displacement limiting circuitry consists of a phase sensor and limit-switch interlocks which work with limit switches in the aircraft throttle mechanism. Operation of the high or low limits is interlocked with the phase sensor to make certain that the system will back away from the limits when polarity of the driving signal reverses. The phase sensor is interlocked with the limit condition to prevent unnecessary relay actuation during normal operation.

F. Monitoring circuitry includes a shaping amplifier and level detector. Command signal input to the servo amplifier is compared to the tachometer feedback signal in the shaping amplifier. Output from the shaping amplifier is applied to a level detector which interrupts system engage logic when a preset difference threshold is exceeded. An adjustable time delay is provided to prevent nuisance actuation of the monitor.



Auto Throttle System
Figure 3

G. The auto throttle control system is automatically disengaged when any one of the following conditions occur:

(1) The monitor in the computer detects a malfunction.

(2) Either auto throttle quick disconnect button is pressed.

(3) Movement of the auto throttle lever to disengage position.

(4) Movement of either No. 2 or No. 3 reverse thrust lever into reverse thrust range.

(5) Rotation of any anti-skid wheel speed transducer.

AUTO THROTTLE - DESCRIPTION AND OPERATION

1. Description

A. The auto throttle system provides the means for automatically controlling the throttle levers to maintain a selected indicated airspeed during approach/landing procedures. The system is independent of the autopilot system and is comprised of an auto throttle lever, a computer with control and interlock circuits, linear accelerometer, servo drive unit (servo drive and gear box), throttle levers drive clutch, engage switch, disengage solenoid, quick-disconnect buttons, and an auto throttle off warning light (see Figures 1 and 1A).

B. Auto Throttle Computer

(1) The auto throttle computer contains the electronic circuits required to process the input signals and generate the electrical output to command servo drive movement. Signal inputs to the computer include airspeed error (including elevator movement), longitudinal acceleration, and pitch attitude. These signals, processed in the auto throttle computer, operate the servo system to provide precise airspeed control with a minimum of throttle lever activity.

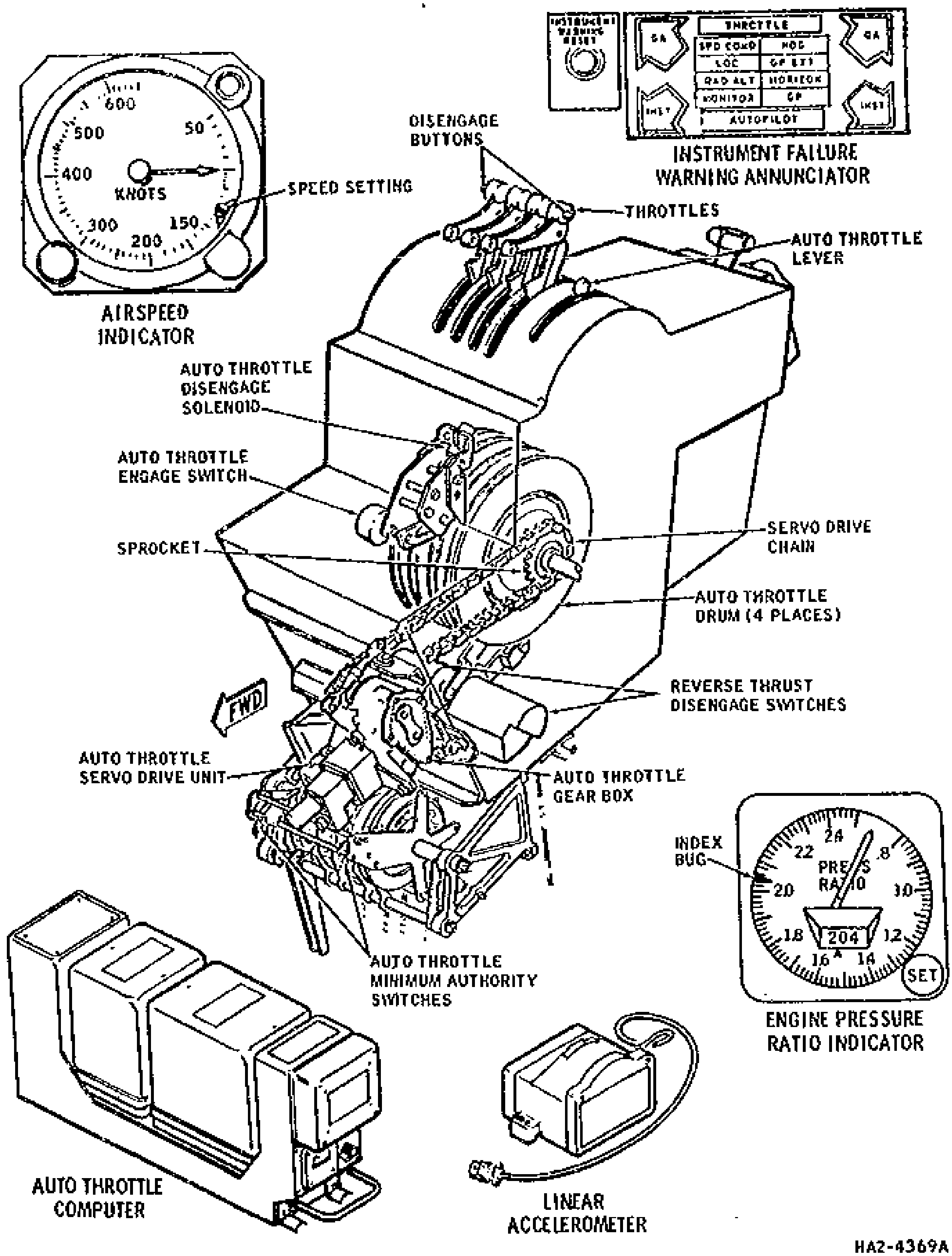
(2) The control and interlock circuits monitor servo drive command signals for system operation within safe maneuver boundaries. Throttle position sensing, through authority switches, is used to prevent the servo system from driving the throttles into regions of excessively high or low engine thrust operation. Throttle movement in the high thrust range is controlled by a switch in each EPR (engine pressure ratio) indicator. Minimum authority switches, located on the thrust reverse gate control assembly, control throttle movement cutoff in the low thrust range.

(3) Monitoring within the computer includes comparison of command signal input with tachometer feedback. System engage logic is interrupted when any malfunction is detected, thus disengaging the system.

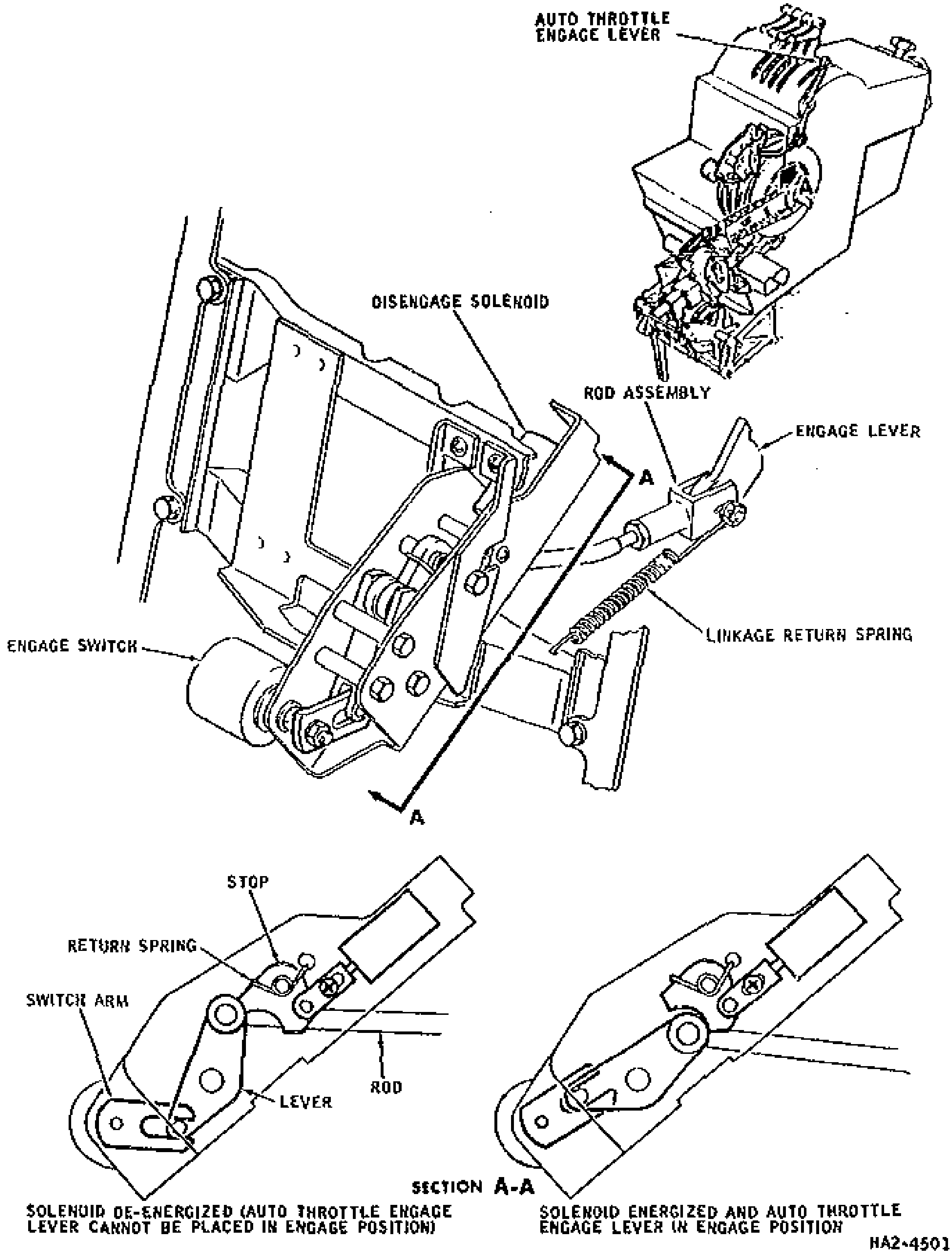
(4) The front panel self-test assembly includes a meter and selector switch for testing of system components.

C. Linear Accelerometer

(1) The linear accelerometer is an electromechanical device that translates longitudinal acceleration into electrical signals. The unit is a hermetically sealed, fluid-damped-type transducer comprised of an E-pickoff transformer and a suspended armature. The E-shaped core of the transformer has the excitation winding on the center leg, and the signal output on the two outer legs. The signal output windings are differentially connected to produce a null (zero output) under static (no forward acceleration) conditions.



Auto Throttle Control System Components
Figure 1



Auto Throttle Lever Linkage
Figure 1A

(2) Self-test coils, actuated by the self-test switch on the auto throttle computer, provide for remote checking of the accelerometer when installed in the airplane.

D. Servo Drive System

(1) The servo drive system includes the servo drive and the airplane gearpack unit located at the forward end of the pilot's control pedestal in the flight compartment. The servo drive includes motor, rate generator, and reduction gears. The airplane gearpack includes a reduction gear train and chain sprocket.

(2) The speed and direction of rotation of the servo motor is proportional to the command signal from the servo amplifier in the auto throttle computer. Servo motor speed is reduced through reduction gears and coupled to the airplane gearpack by means of a splined shaft. Drive speed is further reduced in the gearpack and the output torque at the sprocket drives a chain to position the throttle levers. The servo system drives the throttles at 8 degrees/second at maximum signal input.

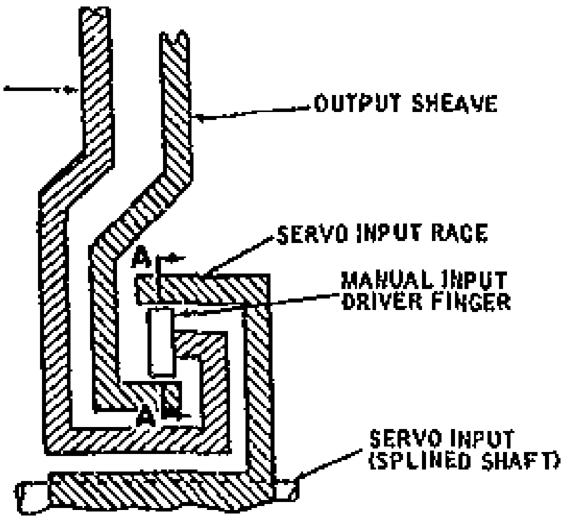
E. Throttle Levers Drive Clutch (See Figure 2.)

(1) The throttle levers drive clutch couples the servo system torque to the engine throttle levers. The clutch assembly can be manually overpowered with a force no greater than ordinarily required for throttle operation with auto throttle system disengaged. At the same time the holding power of the clutch is sufficient to be insensitive to system friction gradients, vibration, or breakaway forces.

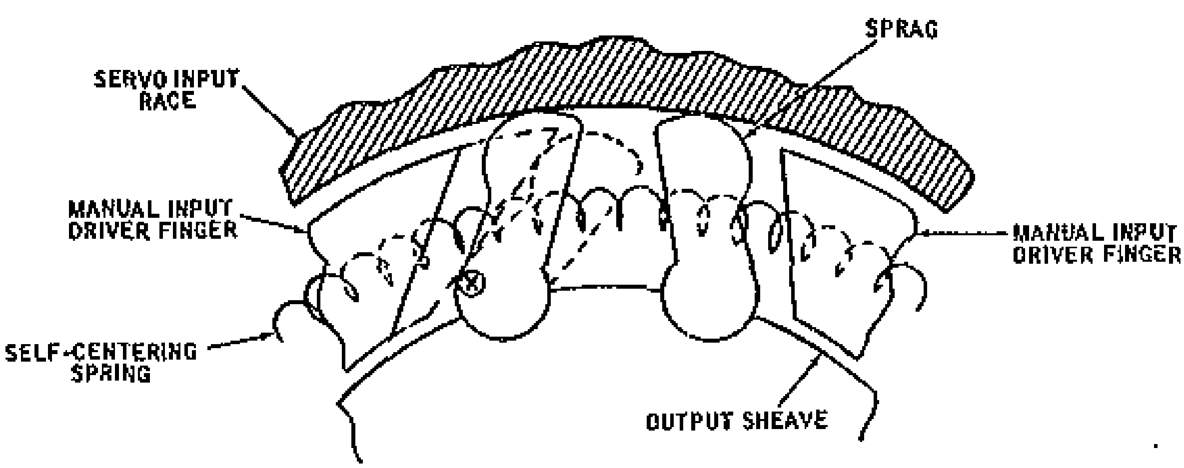
(2) There are four sprag clutch units, one for each throttle lever. Eight manual input driver fingers are mechanically connected to each throttle lever and positioned between four sets of double sprags linked to the output sheave as shown in Section A-A. Note that for each direction of rotation, one of each pair of sprags will jam against the servo input race and the other will slide.

(3) The auto throttle servo system drives the servo input race. As the race moves, the leading sprag in each pair jams and causes the output sheave to rotate. The output sheave is connected to a cable running aft to its respective engine.

(4) Manual operation and overpower of the servo drive system are identical because in both instances the manual input driver fingers release the sprags from the servo input race. When the throttle lever is moved, the driver finger pushes the jam-side sprag of each pair away from the servo input race as shown by dashed lines. Positive driving control is now made between the driver finger and the sprag at point X and direct force is applied to the output sheave.



CUTAWAY VIEW OF CLUTCH - UPPER HALF



SECTION A-A
SPRAG DRIVER SET

HA2-2659

Throttle Clutch Unit
Figure 2

(5) The servo drive system and gear train provide sufficient holding torque against the sprag clutch during manual operation to prevent any creeping of throttle settings.

F. Engage Lever

(1) The auto throttle lever, located adjacent to the throttle levers, provide the means for engaging/disengaging the auto throttle system. The lever is mechanically connected to the auto throttle engage switch. Unless engage logic circuits are satisfied, the lever cannot be moved from the disengage position.

G. Engage Switch

(1) The auto throttle engage switch, located at the forward end of the pilot's control pedestal, closes the circuit between the auto throttle computer and the servo motor. Switch actuation/deactuation is controlled by mechanical linkages connected to the auto throttle lever.

H. Disengage Solenoid

(1) The auto throttle disengage solenoid, located adjacent to the engage switch, is electrically controlled by 28 vdc supplied from the computer, through an interlock circuit. When the solenoid is energized, the auto throttle lever and linkage can be moved to position the engage switch in the engage position. If the electrical circuit to the solenoid is opened while the auto throttle system is engaged, the solenoid deenergizes causing the linkage to move and position the switch and the lever in the disengage position.

I. Authority Switches

(1) During auto throttle system operation, switches are interlocked with the computer to prevent the servo drive from moving the throttle levers into an engine thrust region that would be abnormal or unsafe.

(2) There are 2 minimum authority switches within the pilot's control pedestal to prevent the throttle levers, while being driven aft, to travel past approximately 1 inch forward of the aft throttle stops. Maximum forward throttle lever movement is controlled by a switch which is an integral part of each of the 4 EPR (engine pressure ratio) indicators. An external set knob on the indicators allows the cursor and index bug to be set at the desired maximum EPR indication that the throttles will be driven to. Forward movement of the throttle levers is stopped when the EPR indication on any 1 indicator is within 0.1 of the index bug setting.

J. Reverse Thrust Disengage Switches

(1) Each of the 2 reverse thrust disengage switches is a part of the disengage solenoid interlock circuit and is controlled by a corresponding reverse thrust lever. When either reverse thrust lever (No. 2 or No. 3) is moved into the reverse thrust range, the solenoid deenergizes causing the engage lever linkage to move the lever and engage switch to the disengage position.

K. Quick-Disconnect Buttons

(1) Auto throttle release buttons are located on the outboard side of number one and number four throttle lever handles. For manual take-over (as for example, during go-around) the system is overpowered and released by one hand motion.

L. Auto Throttle Off Warning

(1) A red auto throttle off warning lamp is located in each master failure warning annunciator. The lights will come on whenever the auto throttle is disengaged by any means. The lights can be reset by pressing the monitor reset button located adjacent to each failure annunciator.

M. Auto Throttle Calibrator

(1) The auto throttle calibrator permits plug-in calibration of the auto throttle computer to meet the requirements of different airplane types and series. It also controls the amplitude relationship of electronic signals at various points within the auto throttle computer system. Thus the auto throttle calibrator controls the speed of throttle change in response to a system input. Selection of a particular auto throttle calibrator is determined by airplane aero-dynamics and operating procedures.

(2) The auto throttle calibrator plugs into the front mounted electrical connector of the auto throttle computer (located in the radio rack in the flight compartment). The calibrator must be installed before the system can be tested or put into operation.

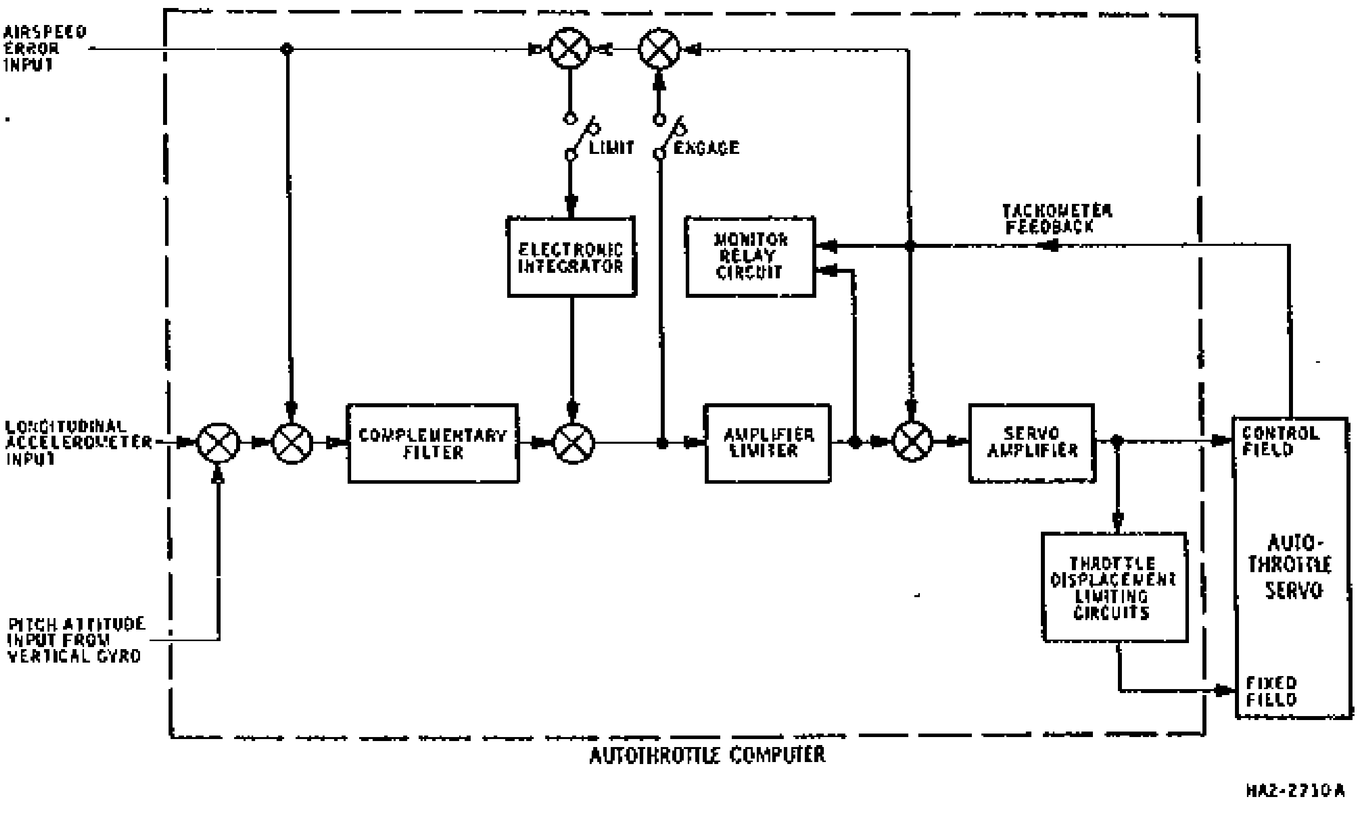
2. System Operation

A. Desired indicated airspeed is manually selected on the speed command indicator by means of the set knob. An error signal (difference between existing and selected airspeed) is fed into the auto throttle computer. This signal is summed with a forward acceleration signal received from the linear accelerometer and a pitch anticipation signal from the elevator position sensor. The final combination is filtered to remove gust induced noise. A pitch reference signal is used to remove any pitch component from the accelerometer signal (see Figure 3).

B. The airspeed error signal is processed through an electronic integrator circuit and summed with the complementary filter output to eliminate stand-off errors due to changes in steady state thrust requirements. A servo tachometer feedback signal, derived from a precision tachometer on the system servo motor, is also sent through the integrator to derive throttle position feedback information.

C. The integrator is also used to synchronize the system in the disengaged mode. The airspeed error signal is disconnected during synchronization to prevent the integrator from wiping out any present airspeed error.

D. With all system engage interlocks satisfied, the auto throttle lever can be moved to and will hold in the engage position. This closes the circuits to allow the servo amplifier to provide power to the control field of the ac servo motor in the form of 400-cps variable width rectangular pulses. Output voltage is a function of pulse width which is controlled by signal level.



Auto Throttle System
Figure 3

E. Throttle displacement limiting circuitry consists of a phase sensor and limit-switch interlocks which work with limit switches in the airplane throttle mechanism and EPR indicators. Operation of the high or low limits is interlocked with the phase sensor to make certain that the system will back away from the limits when polarity of the driving signal reverses. The phase sensor is interlocked with the limit condition to prevent unnecessary relay actuation during normal operation.

F. Monitoring circuitry includes a shaping amplifier and level detector. Command signal input to the servo amplifier is compared to the tachometer feedback signal in the shaping amplifier. Output from the shaping amplifier is applied to a level detector which interrupts system engage logic when a preset difference threshold is exceeded. An adjustable time delay is provided to prevent nuisance actuation of the monitor.

G. The auto throttle control system is automatically disengaged when any one of the following conditions occur:

(1) The monitor in the computer detects a malfunction.

(2) Either auto throttle quick disconnect button is pressed.

(3) Movement of the auto throttle lever to disengage position.

(4) Movement of either No. 2 or No. 3 reverse thrust lever into reverse thrust range.

(5) Rotation of any anti-skid wheel speed transducer.

(6) Speed command system is placed in other than approach mode.

AUTO THROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting the auto throttle system requires proper operation of the auto throttle interlock and the vertical gyro systems. The throttles should be rigged and in working order, and the elevator trailing edge should be at neutral position, 10 (±3/16) inches below marked rivet on the left side of the tail cone.

B. Auto throttle trouble shooting is performed using the captain's controls and indicators. Tests performed at the captain's flight station are primarily system tests and do not alone determine failure of a particular component. Troubles involving throttle motions and airplane dynamics may not be detected during ground check and the area of failure may have to be determined by process of elimination.

2. Tools and Equipment Required

A. A multimeter, Simpson model 260 or equivalent, is required to perform voltage and continuity checks.

3. Trouble Shooting Procedures

Possible Causes	Isolation Procedure	Correction
A. AUTO THROTTLE SYSTEM WILL NOT ENGAGE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace auto throttle computer.
(2) Quick disconnect switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pin 10 and top plug pin 38. No continuity indicates open quick disconnect switch or wiring.	Replace quick disconnect switch or repair wiring as necessary.
(3) Disengage solenoid defective.	Check for 28 vdc at solenoid terminal X1 (throttle levers in mid-quad position).	If 28 vdc is present replace solenoid; if not remove computer. Check continuity between X1 and computer receptacle rack mounted top plug pin 48. Repair as necessary.

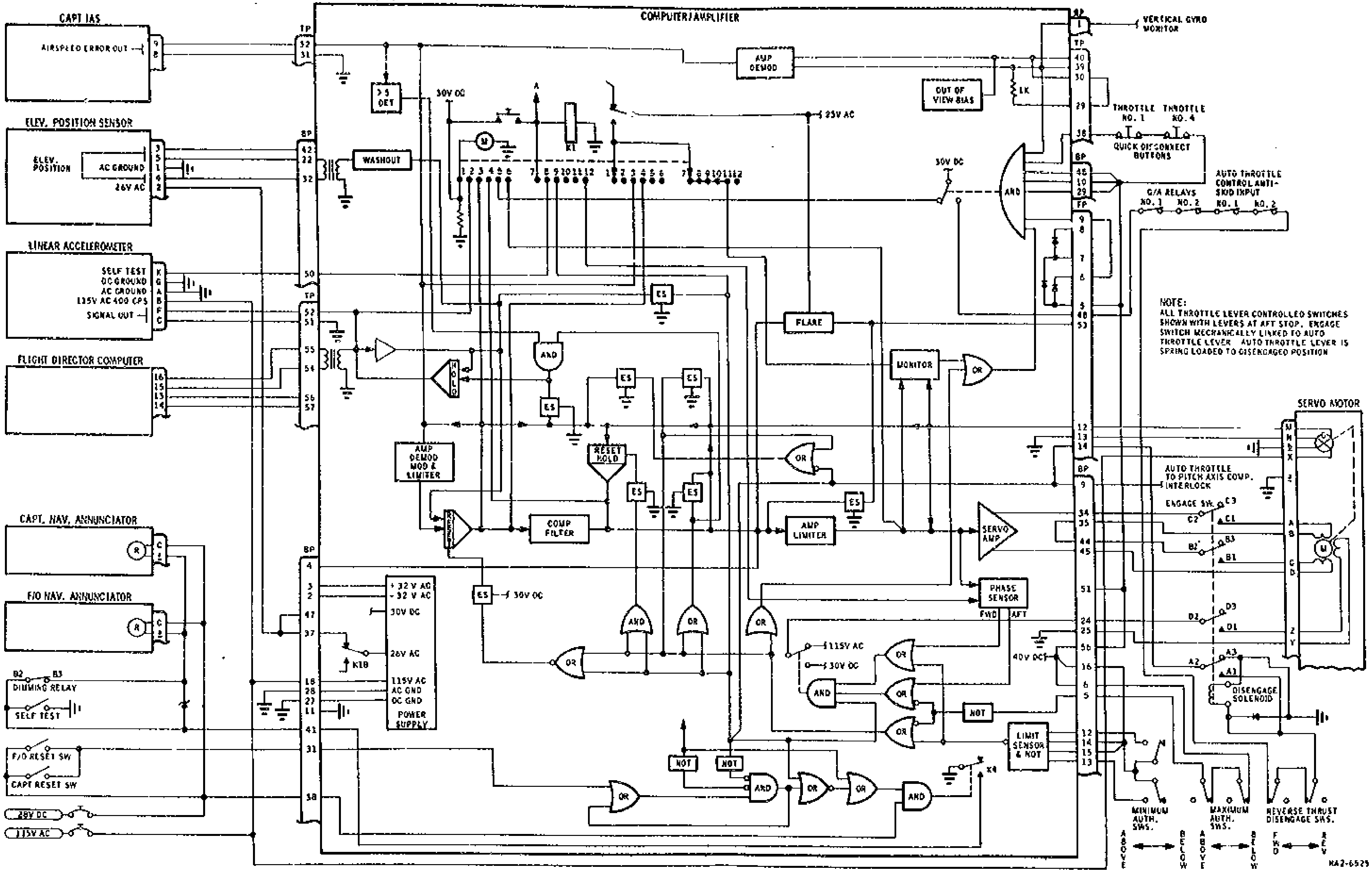
Possible Causes	Isolation Procedure	Correction
B. AUTO THROTTLE LEVER WILL NOT HOLD IN ENGAGE POSITION		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Servo motor defective.	Rotate self-test selector switch to position 4. Self-test meter should indicate below yellow range within 20 seconds. Press and hold press-to-test switch, meter should indicate in yellow range within 30 seconds.	Replace servo motor.
(3) Engage switch defective or wiring defective.	(1) Remove computer. Disconnect servo motor electrical connector, check continuity between rack mounted computer receptacle bottom plug pins 35, 25, and 45, and servo motor connector pins B, D, and Y respectively.	Repair wiring as necessary.
	(2) Check for no continuity between bottom plug pins 34, 44, and 24, and servo connector pins A, C, and Z.	If continuity, replace engage switch.
	(3) Manually hold auto throttle lever in engage position. Repeat step (2) checking for continuity.	If no continuity, replace switch or repair wiring as necessary.
C. AUTO THROTTLE OFF WARNING LIGHTS DO NOT OPERATE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Warning light or wiring defective.	Press instrument failure monitor test switch.	If lights come on repair wiring, if not replace lights.

	Possible Causes	Isolation Procedure	Correction
D.	**AUTO THROTTLE ENGAGES PROPERLY, THROTTLES DO NOT RESPOND**		
(1)	Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2)	Servo motor defective.	Perform computer self-test procedure steps (2) and (14 through 19).	Replace servo motor.
(3)	Airspeed error selector switch defective.	Disconnect captain's and first officer's IAS indicator electrical connector. Remove computer. With airspeed error selector switch in captain position, check for continuity between computer rack mounted receptacle top plug pins 31 and 32 and captain's indicator connector pins 8 and 9 respectively, and no continuity between pins 31 and 32 and first officers indicator connector pins 8 and 9 respectively. Repeat above procedure with switch at first officers position using first officer's indicator connector.	Replace switch or repair wiring as necessary.
(4)	IAS indicator defective.	Observe other indicator. Perform step (3).	Replace indicator or repair wiring as necessary.
E.	**THROTTLE LEVERS MOVE IN WRONG DIRECTION**		
(1)	Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2)	Airspeed error selector switch defective.	Perform step D.(3).	
(3)	IAS indicator defective.	Perform step D.(4).	

Possible Causes	Isolation Procedure	Correction
E. THROTTLE LEVERS MOVE IN WRONG DIRECTION (Continued)		
(4) Engage switch or wiring defective.	Perform step B.(3).	
F. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary (see Chapter 76).
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
G. AUTO THROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
H. THROTTLE LEVERS DO NOT STOP AT UPPER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Maximum authority switch defective.	Remove computer. Check for continuity between rack mounted computer receptacle bottom plug pins 5 and 6. Slowly advance throttles. Continuity should break at 3 13/16 (±29/64) inches forward of aft stop.	Replace or adjust switch as necessary.

Possible Causes	Isolation Procedure	Correction
I. THROTTLES LEVERS DO NOT STOP AT LOWER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Minimum authority switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pins 16 and 12 (pins 14, 15, and 16 are common). While checking continuity slowly retard throttles. Continuity should break at 1 (±1/16) inches forward of aft stop. Repeat procedure using pins 16 and 13.	Replace or adjust switch as necessary.
J. FAST/SLOW INDICATOR DOES NOT FUNCTION PROPERLY		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Fast/slow pointer bias relay defective.	Check for 28 vdc at relay terminal X1.	If 28 vdc is present, replace relay.
(3) Attitude director indicator defective.	Observe other indicator.	Replace defective indicator.
(4) IAS indicator defective.	See isolation procedure D.(3).	
K. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

Possible Causes	Isolation Procedure	Correction
K. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT (Continued)		
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle bottom plug pins 22, 32, and 42, and position sensor connector pins 5, 4, and 3 respectively.	Replace sensor or repair wiring as necessary.



Auto Throttle System -- Schematic
Figure 101

AUTO THROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting the auto throttle system requires proper operation of the auto throttle interlock and the vertical gyro systems. The throttles should be rigged and in working order, and the elevator trailing edge should be at neutral position, 10 (±3/16) inches below marked rivet on left side of the tail cone.

B. Auto throttle trouble shooting is performed using the captain's controls and indicators. Tests performed at the captain's flight station are primarily system tests and do not alone determine failure of a particular component. Troubles involving throttle motions and airplane dynamics may not be detected during ground check and the area of failure may have to be determined by process of elimination.

2. Tools and Equipment Required

A. A multimeter, Simpson model 260 or equivalent, is required to perform voltage and continuity checks.

3. Trouble Shooting Procedures

Possible Causes	Isolation Procedure	Correction
A. AUTO THROTTLE SYSTEM WILL NOT ENGAGE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace auto throttle computer.
(2) Quick disconnect switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pin 10 and top plug pin 38. No continuity indicates open quick disconnect switch or wiring.	Replace quick disconnect switch or repair wiring as necessary.
(3) Disengage solenoid defective.	Check for 28 vdc at solenoid terminal X1 (throttle levers in mid-quad position).	If 28 vdc is present replace solenoid; if not remove computer. Check continuity between X1 and computer receptacle rack mounted top plug pin 48. Repair as necessary.

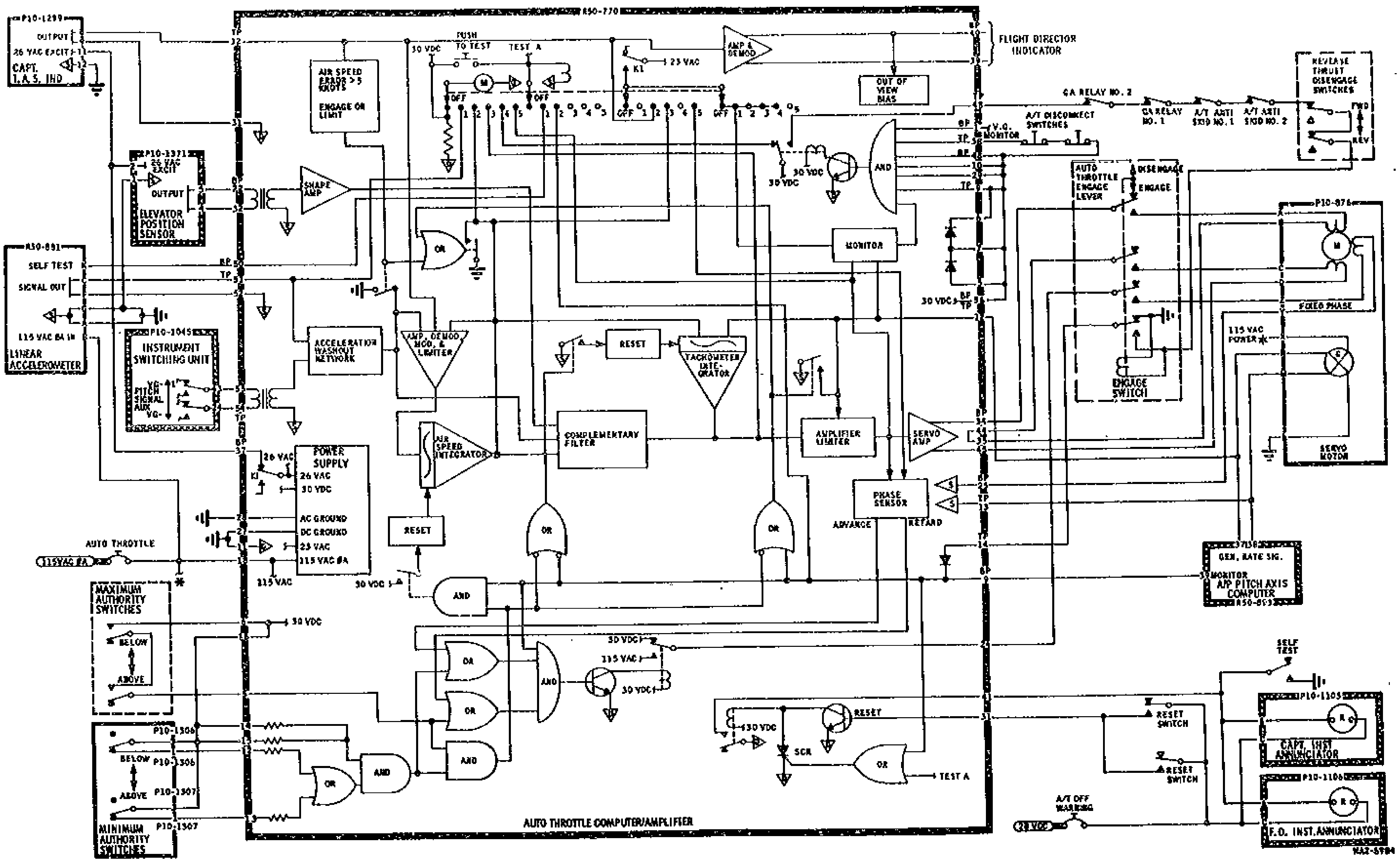
Possible Causes	Isolation Procedure	Correction
B. AUTO THROTTLE LEVER WILL NOT HOLD IN ENGAGE POSITION		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Servo motor defective.	Rotate self-test selector switch to position 4. Self-test meter should indicate below yellow range within 20 seconds. Press and hold press-to-test switch, meter should indicate in yellow range within 30 seconds.	Replace servo motor.
(3) Engage switch defective or wiring defective.	(1) Remove computer. Disconnect servo motor electrical connector, check continuity between rack mounted computer receptacle bottom plug pins 35, 25, and 45, and servo motor connector pins B, D, and Y respectively.	Repair wiring as necessary.
	(2) Check for no continuity between bottom plug pins 34, 44, and 24, and servo connector pins A, C, and Z.	If continuity, replace engage switch.
	(3) Manually hold auto throttle lever in engage position. Repeat step (2) checking for continuity.	If no continuity, replace switch or repair wiring as necessary.
C. AUTO THROTTLE OFF WARNING LIGHTS DO NOT OPERATE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Warning light or wiring defective.	Press instrument failure monitor test switch.	If lights come on repair wiring, if not replace lights.

	Possible Causes	Isolation Procedure	Correction
D.	**AUTO THROTTLE ENGAGES PROPERLY, THROTTLES DO NOT RESPOND**		
(1)	Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2)	Servo motor defective.	Perform computer self-test procedure steps (2) and (14 through 19).	Replace servo motor.
(3)	Airspeed error selector switch defective.	Disconnect captain's and first officer's IAS indicator electrical connector. Remove computer. With airspeed error selector switch in captain position, check for continuity between computer rack mounted receptacle top plug pins 31 and 32 and captain's indicator connector pins 8 and 9 respectively, and no continuity between pins 31 and 32 and first officer's indicator connector pins 8 and 9 respectively. Repeat above procedure with switch at first officers position using first officer's indicator connector.	Replace switch or repair wiring as necessary.
(4)	IAS indicator defective.	Observe other indicator. Perform step (3).	Replace indicator or repair wiring as necessary.
E.	**THROTTLE LEVERS MOVE IN WRONG DIRECTION**		
(1)	Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2)	Airspeed error selector switch defective.	Perform step D.(3).	
(3)	IAS indicator defective.	Perform step D.(4).	

Possible Causes	Isolation Procedure	Correction
E. THROTTLE LEVERS MOVE IN WRONG DIRECTION (Continued)		
(4) Engage switch or wiring defective.	Perform step B.(3).	
F. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary (see Chapter 76).
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
G. AUTO THROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1)..	Replace computer.
H. THROTTLE LEVERS DO NOT STOP AT UPPER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Maximum authority switch defective.	Remove computer. Check for continuity between rack mounted computer receptacle bottom plug pins 5 and 6. Slowly advance throttles. Continuity should break at 3 13/16 (±29/64) inches forward of aft stop.	Replace or adjust switch as necessary.

Possible Causes	Isolation Procedure	Correction
I. THROTTLES LEVERS DO NOT STOP AT LOWER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Minimum authority switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pins 16 and 12, (pins 14, 15, and 16 are common). While checking continuity slowly retard throttles. Continuity should break at 1 (±1/16) inches forward of aft stop. Repeat procedure using pins 16 and 13.	Replace or adjust switch as necessary.
J. FAST/SLOW INDICATOR DOES NOT FUNCTION PROPERLY		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Fast/slow pointer bias relay defective.	Check for 28 vdc at relay terminal X1.	If 28 vdc is present, replace relay.
(3) Attitude director indicator defective.	Observe other indicator.	Replace defective indicator.
(4) IAS indicator defective.	See isolation procedure D.(3).	
K. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

Possible Causes	Isolation Procedure	Correction
K. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT (Continued)		
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle bottom plug pins 22, 32, and 42, and position sensor connector pins 5, 4, and 3 respectively.	Replace sensor or repair wiring as necessary.



Auto Throttle System -- Schematic
Figure 101

AUTOTHROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting procedures consist primarily of isolation of faulty components. In the case of autothrottle electronic components, this can sometimes be accomplished by self-test.

B. A thorough knowledge of the interrelationship of components is essential for meaningful trouble shooting. For this reason, an autothrottle and associated system interface simplified schematic is contained in this section.

C. A Trouble Shooting Index is provided in Paragraph 3. This is to be utilized as an aid to isolate particular problem areas. When a problem arises, isolate the problem area, then use the referenced logic diagram to isolate the faulty component, or defective wiring.

D. Refer to Paragraph 4 for location of circuit breakers that have a direct bearing on the operation of the autothrottle and associated systems.

E. Standard electrical voltages are given in the following procedures, however it is to be understood that a 10% tolerance is permissible unless otherwise stated.

2. Tools and Equipment Required

A. The following equipment or suitable substitute may be required during trouble shooting procedures:

Item	Name	Number	Manufacturer	Use
A	Volt-Ohm Meter	Model 260	Simpson	Used to read ac and dc voltages, and to check circuit continuity, and to measure resistance.

3. Trouble Shooting Index - Autothrottle System

A. The following table lists the malfunctions that are covered in this trouble shooting procedure:

	Malfunction	Figure No.
(1)	Autothrottle Off Warning Lights Remain On	103
(2)	Autothrottle Off Warning Lights Do Not Come On	104
(3)	Autothrottle System Will Not Engage	105
(4)	Throttle Levers Drive Beyond Electrical Stops	106

4. Circuit Breakers

A. Open the following circuit breakers:

CIRCUIT BREAKER	LOCATION
ALL FUEL BOOST PUMP	AC BUSSES 1, 2, 3, & 4
ENGINE STARTERS	BATTERY BUS
ENGINE IGNITION	BATTERY BUS

B. Close the following circuit breakers:

CIRCUIT BREAKER	LOCATION
AUTOTHROTTLE 115 VAC	RADIO BUS 2
AUTOTHROTTLE OFF WARNING	RADIO BUS 3
ANTI-SKID SYSTEM	DC BUSSES 1 & 4
GROUND SPOILER CONTROL	AC BUS 4
VERTICAL GYRO 2	RT AC EMER BUS
AUX VERTICAL GYRO	RIGHT & LEFT AC EMER BUSSES
VERT GYRO TRANSFER	RIGHT DC EMER BUS

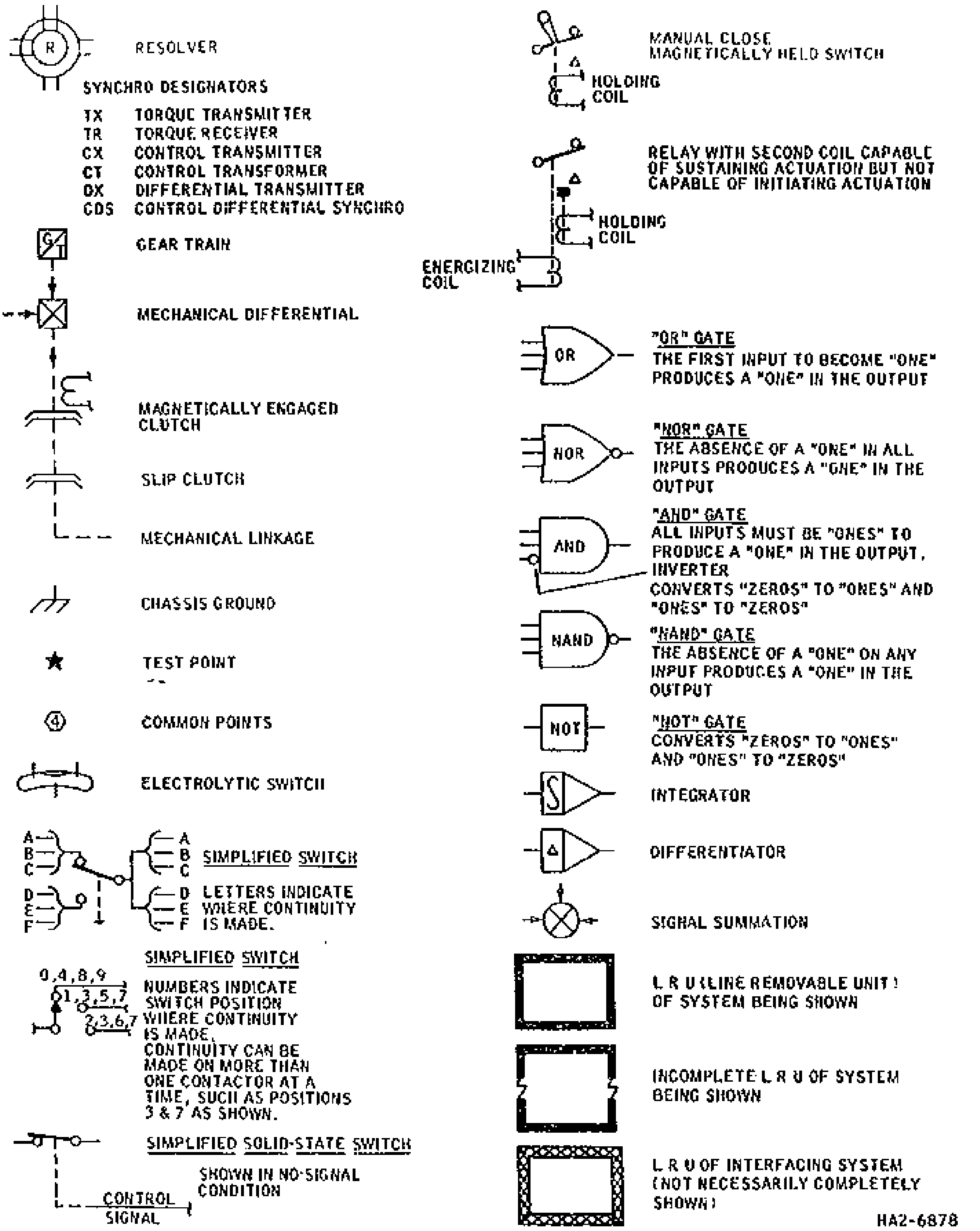
CIRCUIT BREAKER	LOCATION
NAVIGATION INST XFMR 1 & 2	RADIO BUSSES 2 & 3
RADIO BUS 2 LOAD MONITOR	RADIO BUS 2
RADIO BUS 3 LOAD MONITOR	RADIO BUS 3

5. Additional Throttle Response Problems

Possible Causes	Isolation Procedure	Correction
A. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle P10-770 bottom plug pins 22 & 32, and position sensor connector pins 5 & 4, respectively.	Replace sensor or repair wiring as necessary.
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary.

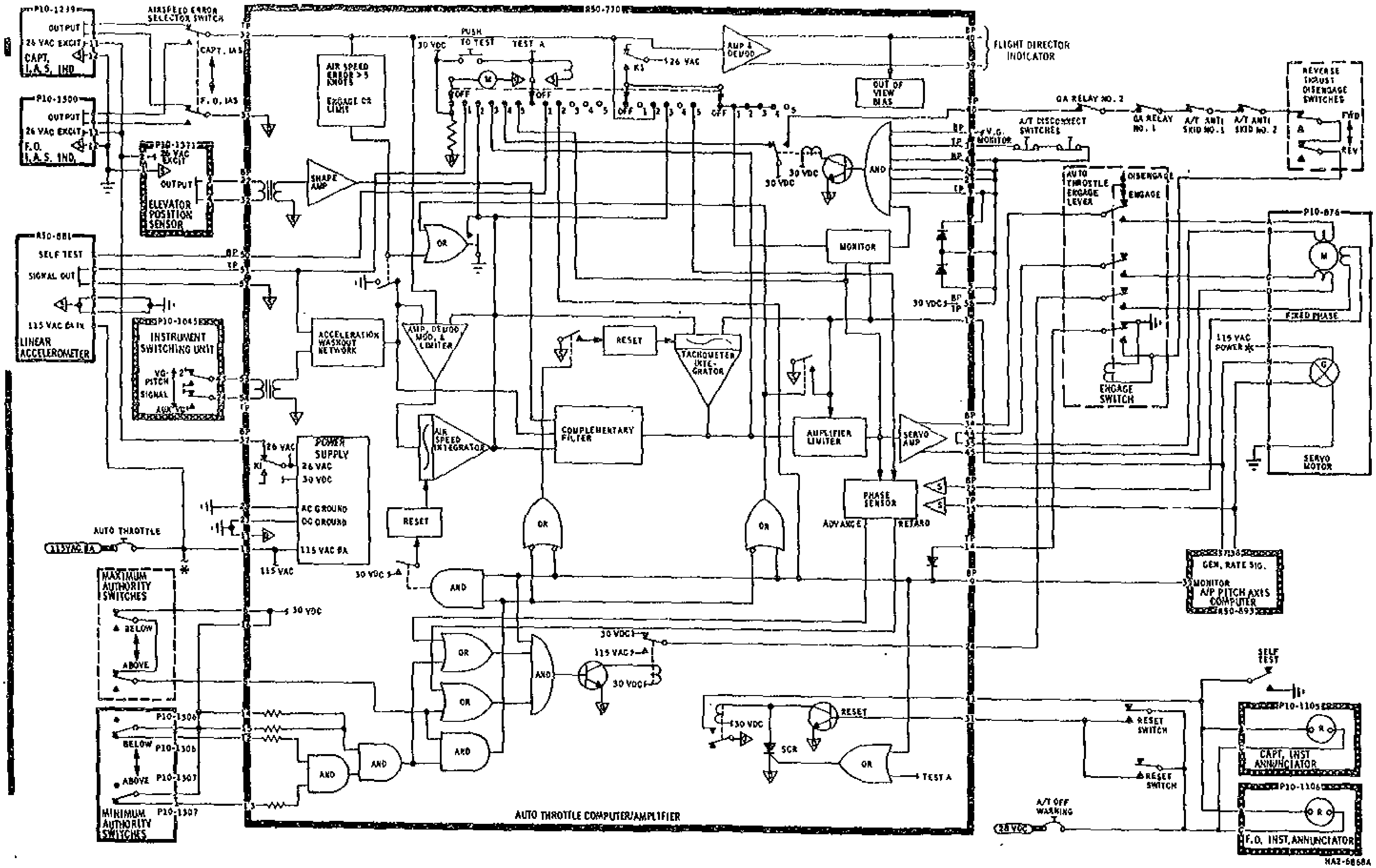
Possible Causes	Isolation Procedure	Correction
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE) (Continued)		
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
C. AUTOTHROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

SCHEMATIC SYMBOLS NOT COVERED BY ATA 100



Schematic Symbols
Figure 101

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Autothrottle System -- Schematic
Figure 102

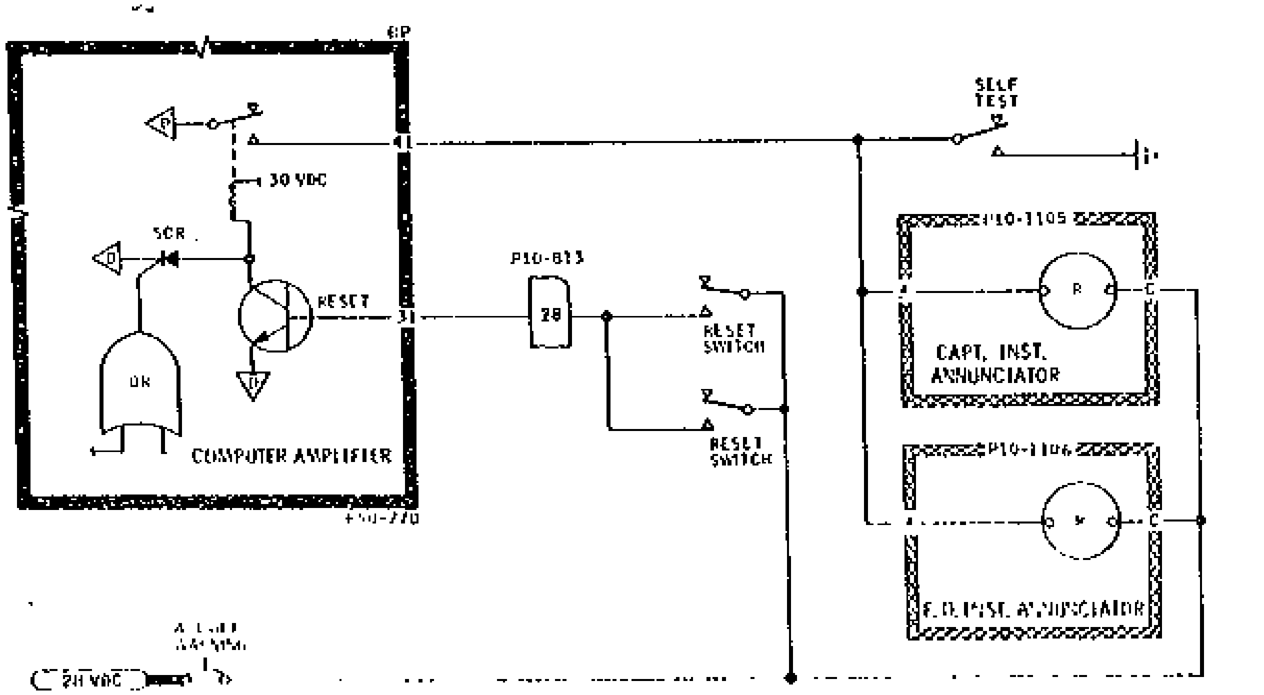
AUTOTHROTTLE OFF WARNING LIGHTS REMAIN ON

PROBABLE FAULT

1. AUTOTHROTTLE COMPUTER.
2. AUTOTHROTTLE RESET SWITCHES.
3. DEFECTIVE WIRING.

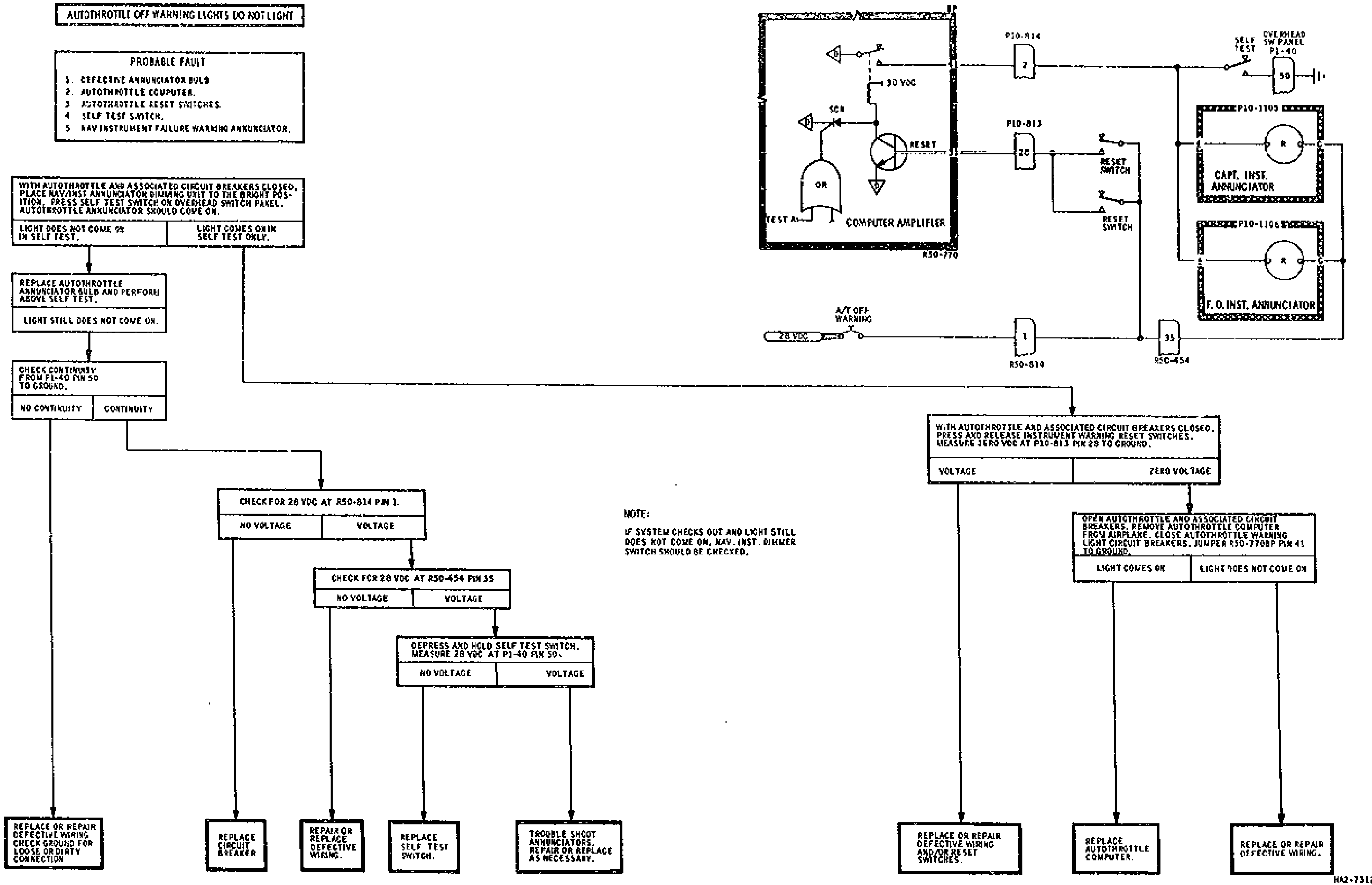
PRESS AND RELEASE AUTOTHROTTLE RESET SWITCHES.
- LIGHT REMAINS ON

WITH AUTOTHROTTLE RESET SWITCHES OPEN, MEASURE 0 VDC AT P10-813 PIN 29 TO GROUND.
- VOLTAGE: REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE RESET SWITCHES.
- 0 VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKER. LIGHT SHOULD BE OUT.
  - LIGHT REMAINS ON: REPLACE OR REPAIR DEFECTIVE WIRING. (R50-770 PIN 41 THROUGH FAILURE WARNING ANNUNCIATORS). CHECK FOR SHORT CIRCUITS TO GROUND.
  - LIGHT GOES OUT: REPLACE AUTOTHROTTLE COMPUTER.



Autothrottle Off Warning Lights Remain On
Figure 103

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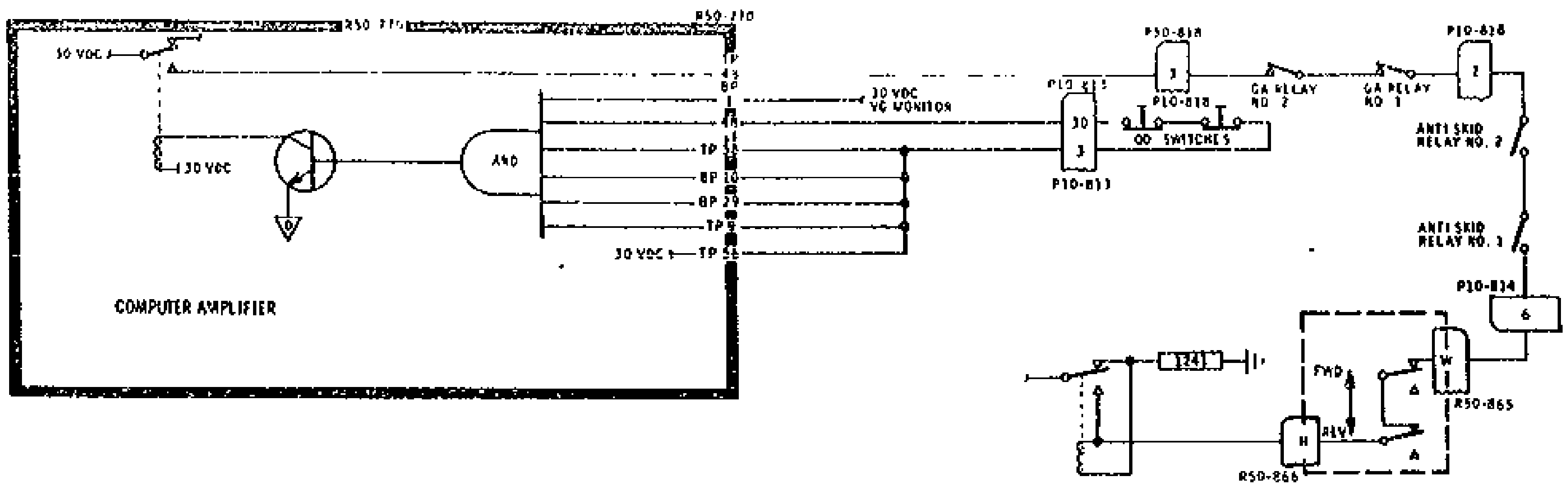


Autothrottle Off Warning Lights Do Not Light
Figure 104

AUTOTHROTTLE SYSTEM WILL NOT ENGAGE (AUTOTHROTTLE LEVER REMAINS LOCKED IN THE DISENGAGE POSITION)

PROBABLE FAULT

1. AUTOTHROTTLE ENGAGE SWITCH.
2. AUTOTHROTTLE COMPUTER.
3. GO-AROUND MODE RELAYS.
4. AUTOTHROTTLE ANTI-SKID RELAYS.
5. THROTTLE DISENGAGE SWITCHES.

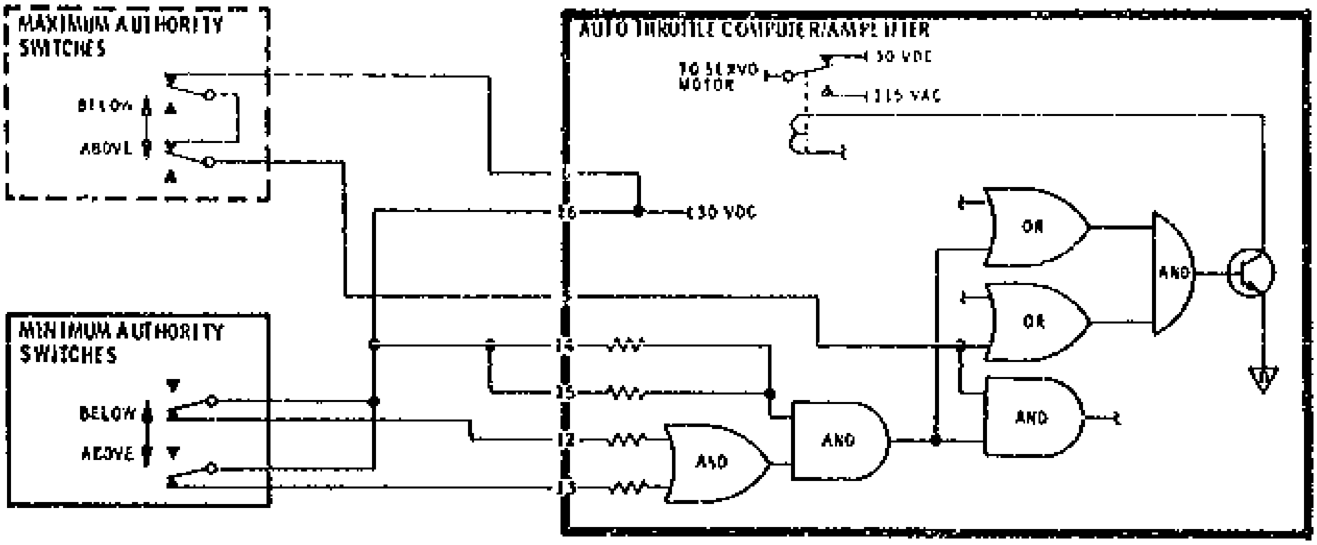


CLOSE ALL AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS.

CHECK 28 VDC AT P10-814, PIN 6
- NO VOLTAGE → CHECK 28 VDC AT P10-818, PIN 2
  - VOLTAGE → REPAIR OR REPLACE ANTISKID SWITCHES AND OR ASSOCIATED WIRING.
  - NO VOLTAGE → CHECK 28 VDC AT P10-818, PIN 3
    - VOLTAGE → REPAIR OR REPLACE G/A SWITCHES AND/OR ASSOCIATED WIRING.
    - NO VOLTAGE → OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS, AND REMOVE COMPUTER AMPLIFIER. CHECK CONTINUITY BETWEEN P10-770 PIN 46(TP), AND P10-818 PIN 3.
      - CONTINUITY → VERIFY ENGAGE LOGIC CIRCUITS AS FOLLOWS:
        ON COMPUTER AMPLIFIER CHECK CONTINUITY BETWEEN THE FOLLOWING POINTS:
        1. R50-770 PIN 56(BP) TO PIN 9(TP).
        2. R50-770 PIN 56(BP) TO PIN 29(BP).
        3. R50-770 PIN 56(BP) TO PIN 10(BP)
        4. R50-770 PIN 56(BP) TO PIN 38(TP).
        5. R50-770 PIN 56(BP) TO PIN 48(BP).
        - CONTINUITY → CLOSE AUTO THROTTLE AND ASSOCIATED CIRCUIT BREAKERS AND CHECK 28 VDC AT P10-779 PIN 1 (BP). (VG MONITOR)
          - VOLTAGE → CHECK CONTINUITY BETWEEN P10-770 PIN 38(TP) AND PIN 48(BP). (THIS CHECKS OUT QUICK DISCONNECT SWITCHES).
            - CONTINUITY → REPLACE COMPUTER AMPLIFIER
            - NO CONTINUITY → REPAIR OR REPLACE QUICK DISCONNECT SWITCHES AND/OR ASSOCIATED WIRING AS NECESSARY.
          - NO VOLTAGE
        - NO CONTINUITY → REPLACE COMPUTER AMPLIFIER
      - NO CONTINUITY → REPAIR OR REPLACE DEFECTIVE WIRING
- VOLTAGE → CHECK 28 VDC AT R50-865 PIN H.
  - VOLTAGE → REMOVE WIRE Q503 AX 24N FROM GROUND STUD 1241 (RADIO RACK SHELF NO. 2 AND CHECK 28 VDC FROM WIRE TERMINAL TO GROUND.
    NOTE: IN EITHER CASE REPAIR OR REPLACE DEFECTIVE WIRING, AND/OR ENGAGE RELAY.
  - NO VOLTAGE → REPAIR OR REPLACE REVERSE THRUST SWITCHES AND ASSOCIATED WIRING.

HA2-7318

Autothrottle Will Not Engage
Figure 105



WITH AUTO THROTTLE ENGAGED, THROTTLE LEVERS DRIVE BEYOND ELECTRICAL STOPS.

PROBABLE CAUSES:

MINIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

MAXIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

IN WHICH DIRECTION DO THROTTLES DRIVE BEYOND LIMITS?

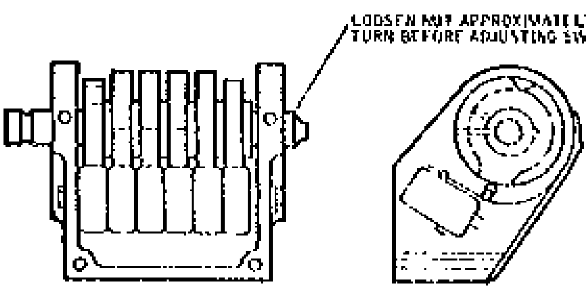
MAXIMUM	MINIMUM

MAXIMUM:

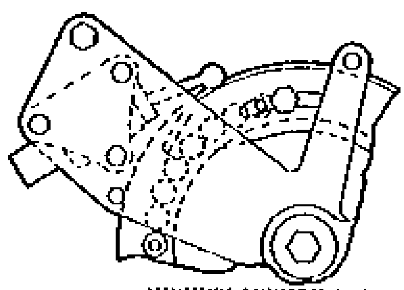
1. POSITION NUMBER 2 AND NUMBER 3 THROTTLE LEVER 3 13/16 ± 1/16 INCHES FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLER MOVES FROM LOW TO HIGH PORTION OF CAM.
3. TORQUE CAM SHAFT RETAINING NUT 30-60 INCH POUNDS AND SECURE WITH COTTER KEY.
4. VERIFY THAT SWITCHES DEACTUATE AT 3 13/16 INCHES FORWARD OF AFT STOP WHILE THROTTLES ARE MOVING IN POWER ON DIRECTION.

MINIMUM:

1. POSITION NUMBER 1 AND NUMBER 4 THROTTLE LEVER 1 INCH FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLERS MOVE FROM HIGH TO LOW PORTION OF CAM.
3. VERIFY THAT SWITCHES DEACTUATE 1 ± 1/16 INCHES FROM AFT STOP WHILE THROTTLE LEVERS ARE MOVING IN POWER OFF DIRECTION.



CAM ASSEMBLY-PEDESTAL THROTTLE SWITCHES



MINIMUM AUTHORITY SWITCH

BA2-7070

Autothrottle Levers Drive Beyond Limits
Figure 106

AUTOTHROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting procedures consist primarily of isolation of faulty components. In the case of autothrottle electronic components, this can sometimes be accomplished by self-test.

B. A thorough knowledge of the interrelationship of components is essential for meaningful trouble shooting. For this reason, an autothrottle and associated system interface simplified schematic is contained in this section.

C. A Trouble Shoot' ıg Index is provided in paragraph 3. This is to be utilized as an aid to isolate particular problem areas. When a problem arises, isolate the problem area, then use the referenced logic diagram to isolate the faulty component, or defective wiring.

D. Refer to paragraph 4 for location of circuit breakers that have a direct bearing on the operation of the autothrottle and associated systems.

E. Standard electrical voltages are given in the following procedures, however it is to be understood that a 10% tolerance is permissible unless otherwise stated.

2. Tools and Equipment Required

A. The following equipment or suitable substitute may be required during trouble shooting procedures:

Item	Name	Number	Manufacturer	Use
A	Volt-Ohm Meter	Model 260	Simpson	Used to read ac and dc voltages, and to check circuit continuity, and to measure resistance.

3. Trouble Shooting Index - Autothrottle System

A. The following table lists the malfunctions that are covered in this trouble shooting procedure:

Malfunction	Figure No.
(1) Autothrottle Off Warning Lights Remain On	103
(2) Autothrottle Off Warning Lights Do Not Come On	104
(3) Autothrottle System Will Not Engage	105
(4) Throttle Levers Drive Beyond Electrical Stops	106

4. Circuit Breakers

A. Open the following circuit breakers:

CIRCUIT BREAKER	LOCATION
ALL FUEL BOOST PUMP	AC BUSSES 1, 2, 3, & 4
ENGINE STARTERS	BATTERY BUS
IGNITION PWR SUPPLY	BATTERY BUS
IGNITION PWR SUPPLY CONT	BATTERY BUS

B. Close the following circuit breakers:

CIRCUIT BREAKER	LOCATION
AUTOTHROTTLE 115 VAC	RADIO BUS 2
AUTOTHROTTLE OFF WARNING	RADIO BUS 3
ANTI-SKID SYSTEM	DC BUSSES 1 & 4
GROUND SPOILER CONTROL	AC BUS 4
CAPTAIN'S HORIZON	LEFT AC EMER BUS
GO AROUND 1 & 2	RADIO BUSSES 2 & 3

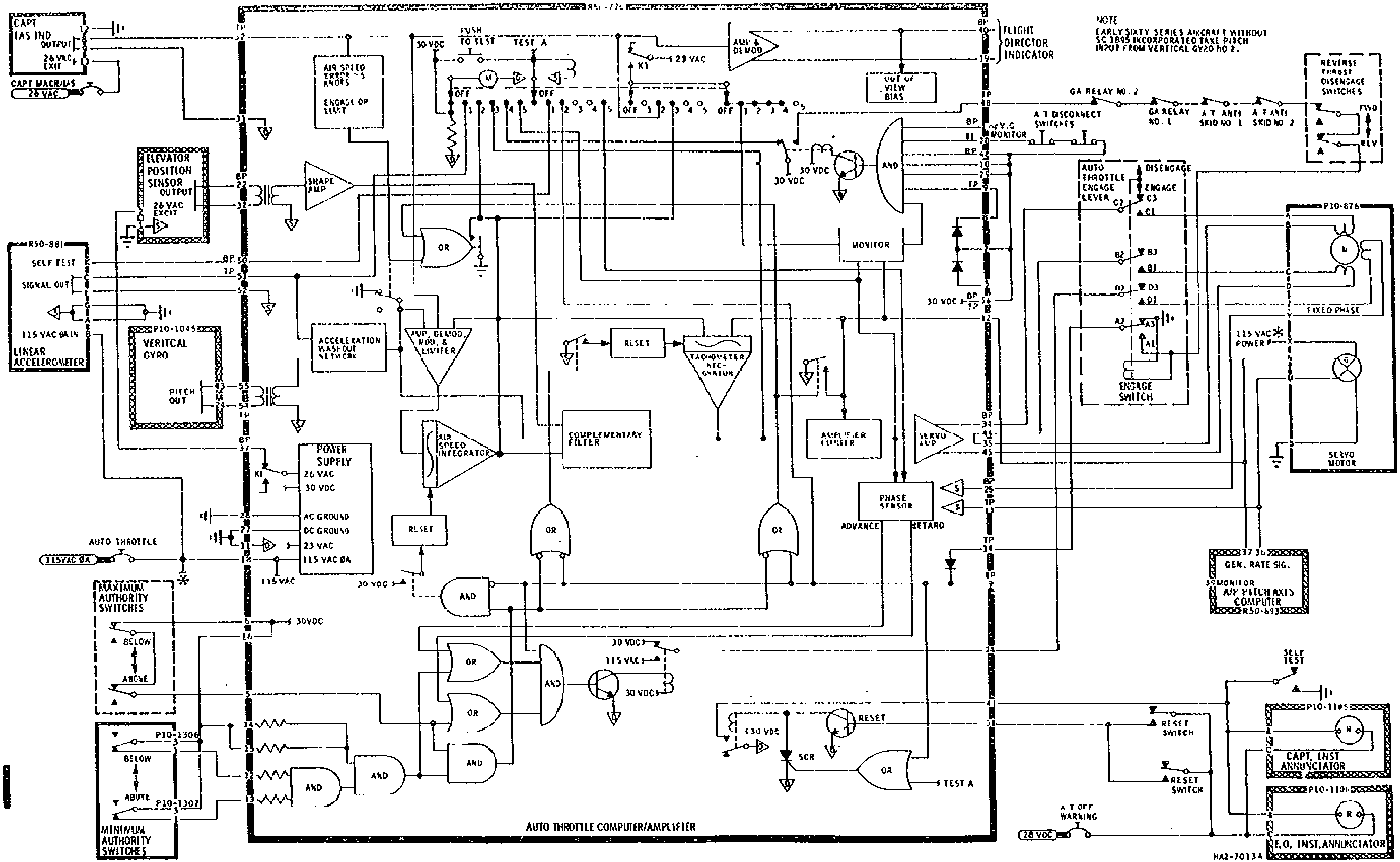
CIRCUIT BREAKER	LOCATION
RADIO BUS 2 LOAD MONITOR	RADIO BUS 2
RADIO BUS 3 LOAD MONITOR	RADIO BUS 3

5. Additional Throttle Response Problems

Possible Causes	Isolation Procedure	Correction
A. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle P10-770 bottom plug pins 22 & 32, and position sensor connector pins 5 & 4, respectively.	Replace sensor or repair wiring as necessary.
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary.
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.

Possible Causes	Isolation Procedure	Correction
C. AUTOTHROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

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NOTE
EARLY SIXTY SERIES AIRCRAFT WITHOUT SC 3895 INCORPORATED TAKE PITCH INPUT FROM VERTICAL GYRO NO 2.
AUTO THROTTLE COMPUTER/AMPLIFIER
FLIGHT DIRECTOR INDICATOR
REVERSE THRUST DISENGAGE SWITCHES
ENGAGE SWITCH
SERVO MOTOR
GEN. RATE SIG.
A/P PITCH AXIS COMPUTER
CAPT. INST ANNUNCIATOR
F.O. INST. ANNUNCIATOR
MAXIMUM AUTHORITY SWITCHES
MINIMUM AUTHORITY SWITCHES
LINEAR ACCELEROMETER
VERTICAL GYRO
ELEVATOR POSITION SENSOR
POWER SUPPLY
COMPLEMENTARY FILTER
PHASE SENSOR
HA2-70134

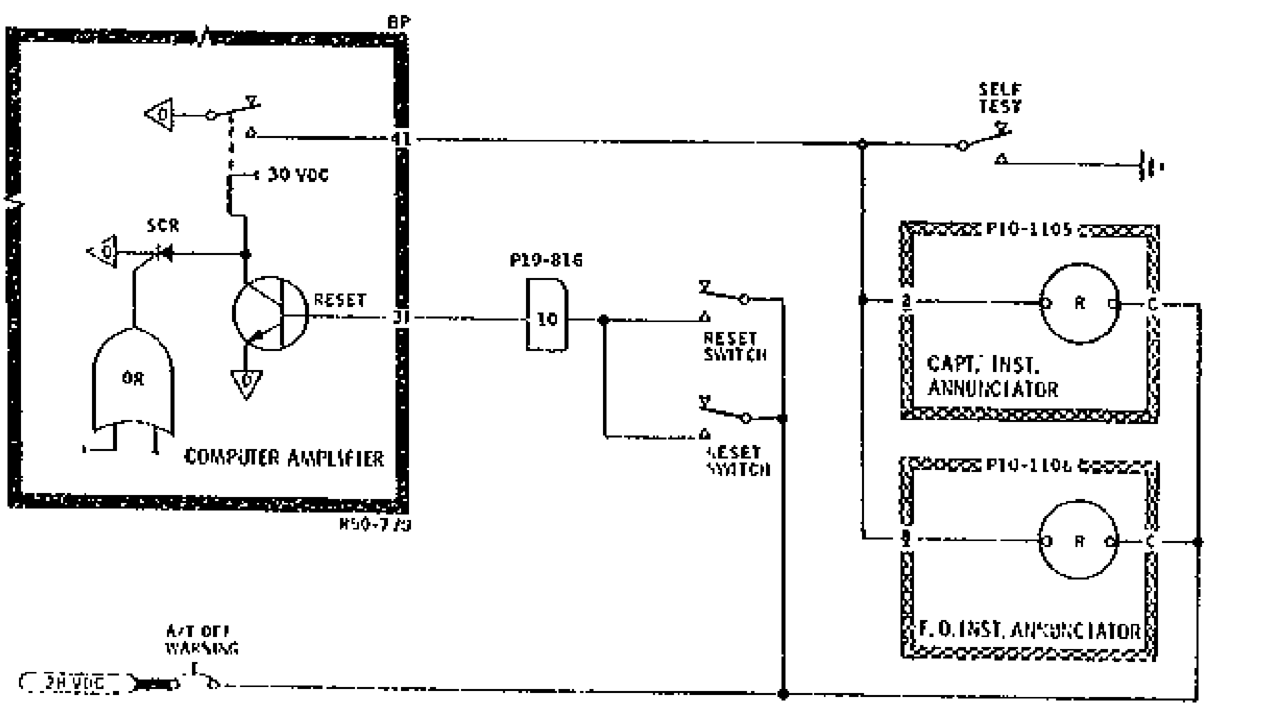
AUTOTHROTTLE OFF WARNING LIGHTS REMAIN ON

PROBABLE FAULT

1. AUTOTHROTTLE COMPUTER
2. AUTOTHROTTLE RESET SWITCHES
3. DEFECTIVE WIRING.

PRESS AND RELEASE AUTOTHROTTLE RESET SWITCHES.
- LIGHT REMAINS ON

WITH AUTOTHROTTLE RESET SWITCHES OPEN, MEASURE 0 VDC AT P10-818 PIN 10 TO GROUND.
- VOLTAGE: REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE RESET SWITCHES.
- 0 VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKER. LIGHT SHOULD GO OUT.
  - LIGHT REMAINS ON: REPLACE OR REPAIR DEFECTIVE WIRING. (R50-770 PIN 41 THROUGH FAILURE WARNING ANNUNCIATORS). CHECK FOR SHORT CIRCUITS TO GROUND.
  - LIGHT GOES OUT: REPLACE AUTOTHROTTLE COMPUTER.



HA7-7760

Autothrottle Off Warning Lights Remain On
Figure 103

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AUTOTHROTTLE OFF WARNING LIGHTS DO NOT LIGHT

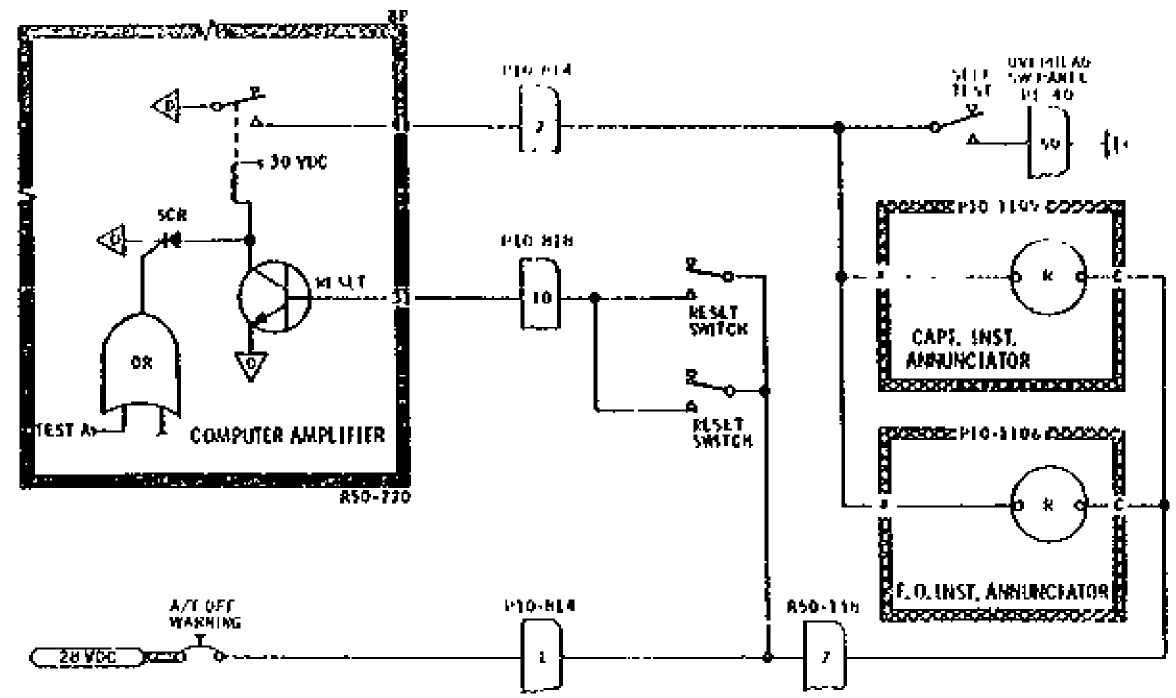
PROBABLE FAULT

1. DEFECTIVE ANNUNCIATOR BULB
2. AUTOTHROTTLE COMPUTER.
3. AUTOTHROTTLE RESET SWITCHES.
4. SELF TEST SWITCH
5. NAV INSTRUMENT FAILURE WARNING ANNUNCIATOR.

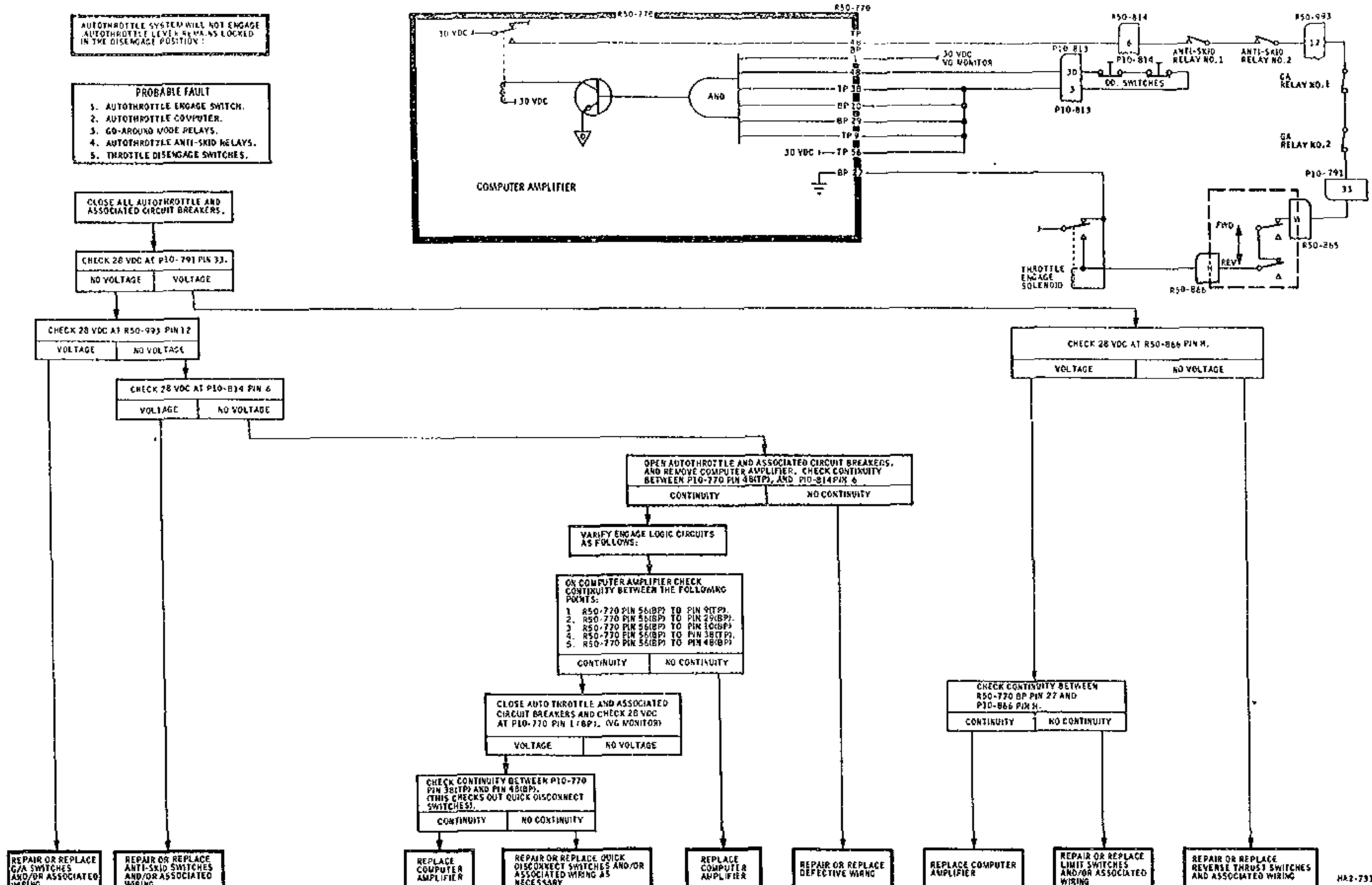
WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PLACE NAV INST ANNUNCIATOR DIMMING UNIT TO THE BRIGHT POSITION. PRESS SELF TEST SWITCH ON OVERHEAD SWITCH PANEL. AUTOTHROTTLE ANNUNCIATOR SHOULD COME ON.

- LIGHT DOES NOT COME ON IN SELF TEST.
  - REPLACE AUTOTHROTTLE ANNUNCIATOR BULB AND PERFORM ABOVE SELF TEST.
    - LIGHT STILL DOES NOT COME ON.
      - CHECK CONTINUITY FROM P1-40 PIN 50 TO GROUND.
        - NO CONTINUITY: REPLACE OR REPAIR DEFECTIVE WIRING. CHECK GROUND FOR LOOSE OR DIRTY CONNECTION.
        - CONTINUITY: CHECK FOR 28 VDC AT P10-814 PIN 1
          - NO VOLTAGE: REPLACE CIRCUIT BREAKER.
          - VOLTAGE: CHECK FOR 28 VDC AT R50-116 PIN 7
            - NO VOLTAGE: REPAIR OR REPLACE DEFECTIVE WIRING.
            - VOLTAGE: DEPRESS AND HOLD SELF TEST SWITCH. MEASURE 28 VDC AT P1-40 PIN 50.
              - NO VOLTAGE: REPLACE SELF TEST SWITCH.
              - VOLTAGE: TROUBLE SHOOT ANNUNCIATORS. REPAIR OR REPLACE AS NECESSARY.
- LIGHT COMES ON IN SELF TEST ONLY.
  - WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PRESS AND RELEASE INSTRUMENT WARNING RESET SWITCHES. MEASURE ZERO VDC AT P10-818 PIN 10 TO GROUND.
    - VOLTAGE: REPLACE OR REPAIR DEFECTIVE WIRING AND/OR RESET SWITCHES.
    - ZERO VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKERS. JUMPER P10-770BP PIN 41 TO GROUND.
      - LIGHT COMES ON: REPLACE AUTOTHROTTLE COMPUTER.
      - LIGHT DOES NOT COME ON: REPLACE OR REPAIR DEFECTIVE WIRING.

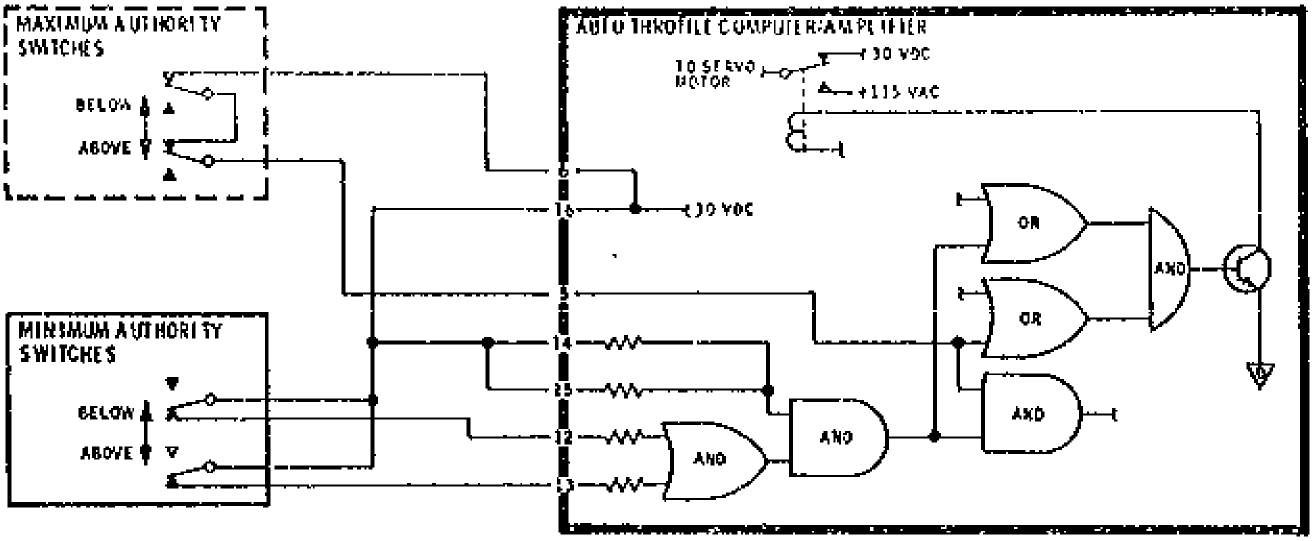
NOTE:
IF SYSTEM CHECKS OUT AND LIGHT STILL DOES NOT COME ON, NAV. INST. DIMMER SWITCH SHOULD BE CHECKED.



HA2-7267



Autothrottle System Will Not Engage
Figure 105



WITH AUTO THROTTLE ENGAGED, THROTTLE LEVERS DRIVE BEYOND ELECTRICAL STOPS.

PROBABLE CAUSES:

MINIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

MAXIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

IN WHICH DIRECTION DO THROTTLES DRIVE BEYOND LIMITS?

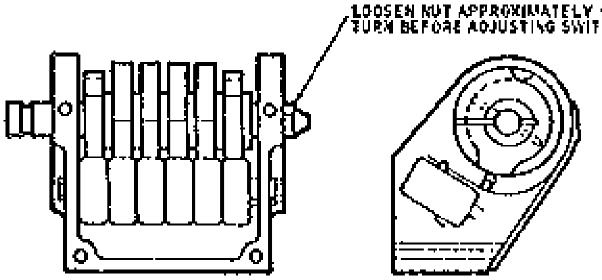
MAXIMUM	MINIMUM

MAXIMUM:

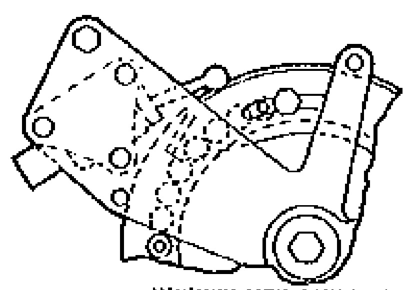
1. POSITION NUMBER 2 AND NUMBER 3 THROTTLE LEVER 3 13/16 ± 1/16 INCHES FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLER MOVES FROM LOW TO HIGH PORTION OF CAM.
3. TORQUE CAM SHAFT RETAINING NUT TO 60 INCH POUNDS AND SECURE WITH COTTER KEY.
4. VERIFY THAT SWITCHES DEACTUATE AT 3 13/16 INCHES FORWARD OF AFT STOP WHILE THROTTLES ARE MOVING IN POWER ON DIRECTION.

MINIMUM:

1. POSITION NUMBER 1 AND NUMBER 4 THROTTLE LEVER 1 INCH FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLERS MOVE FROM HIGH TO LOW PORTION OF CAM.
3. VERIFY THAT SWITCHES DEACTUATE 1 ± 1/16 INCHES FROM AFT STOP WHILE THROTTLE LEVERS ARE MOVING IN POWER OFF DIRECTION.



CAM ASSEMBLY-PEDESTAL THROTTLE SWITCHES



MINIMUM AUTHORITY SWITCH

HAZ-7070

Throttle Levers Drive Beyond Electrical Stops
Figure 106

AUTO THROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting the auto throttle system requires proper operation of the auto throttle interlock and the vertical gyro systems. The throttles should be rigged and in working order, and the elevator trailing edge should be at neutral position, 10 (±3/16) inches below marked rivet on the left side of the tail cone.

B. Auto throttle trouble shooting is performed using the captain's controls and indicators. Tests performed at the captain's flight station are primarily system tests and do not alone determine failure of a particular component. Troubles involving throttle motions and airplane dynamics may not be detected during ground check and the area of failure may have to be determined by process of elimination.

2. Tools and Equipment Required

A. A multimeter, Simpson model 260 or equivalent, is required to perform voltage and continuity checks.

3. Trouble Shooting Procedures

Possible Causes	Isolation Procedure	Correction
A. AUTO THROTTLE SYSTEM WILL NOT ENGAGE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace auto throttle computer.
(2) Quick disconnect switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pin 10 and top plug pin 38. No continuity indicates open quick disconnect switch or wiring.	Replace quick disconnect switch or repair wiring as necessary.

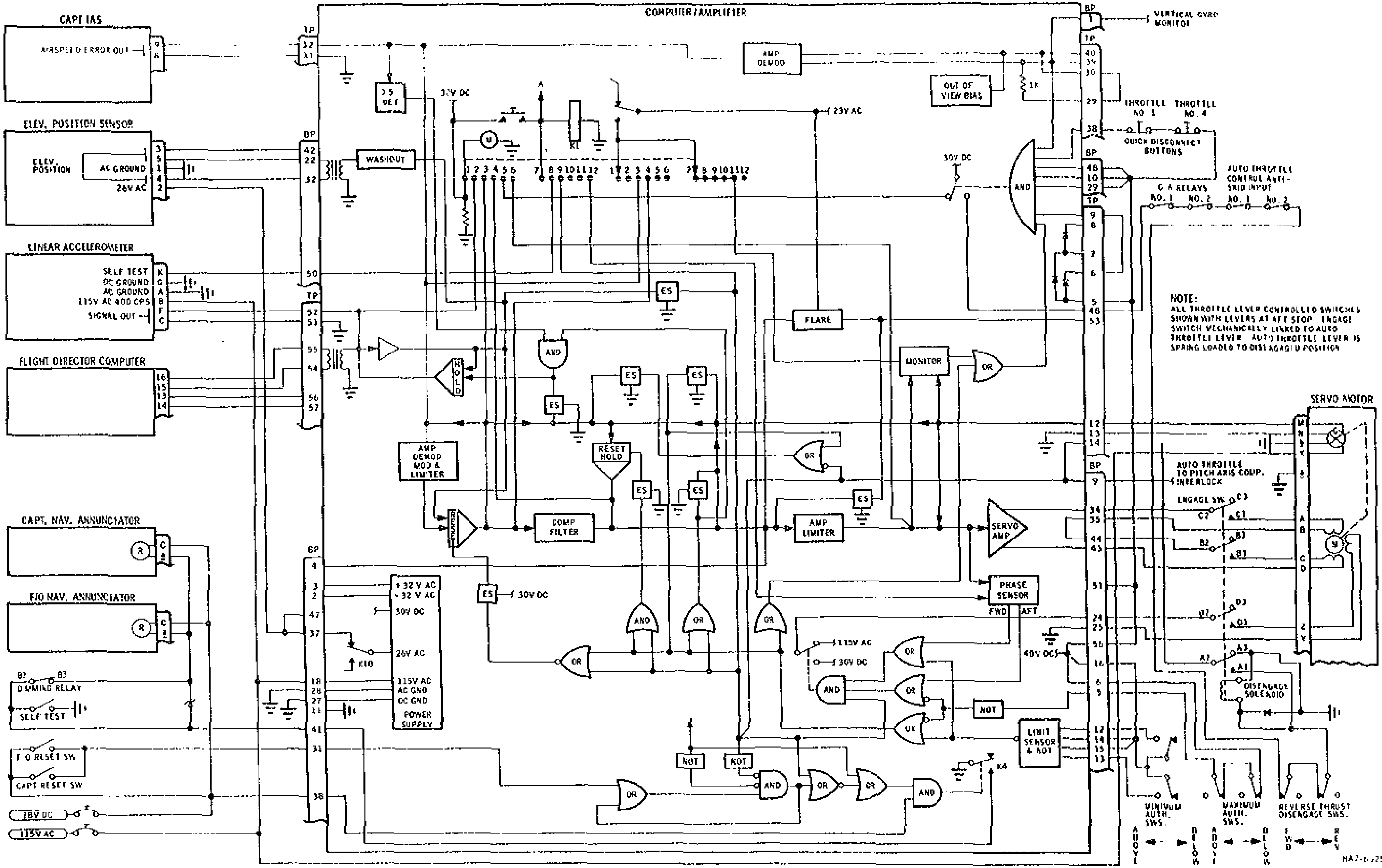
Possible Causes	Isolation Procedure	Correction
A. AUTO THROTTLE SYSTEM WILL NOT ENGAGE (Continued)		
(3) Disengage solenoid defective.	Check for 28 vdc at solenoid terminal X1 (throttle levers in mid-quad position).	If 28 vdc is present replace solenoid; if not remove computer. Check continuity between X1 and computer receptacle rack mounted top plug pin 48. Repair as necessary.
B. AUTO THROTTLE LEVER WILL NOT HOLD IN ENGAGE POSITION		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Servo motor defective.	Rotate self-test selector switch to position 4. Self-test meter should indicate below yellow range within 20 seconds. Press and hold press-to-test switch, meter should indicate in yellow range within 30 seconds.	Replace servo motor.
(3) Engage switch defective or wiring defective.	(1) Remove computer, disconnect servo motor electrical connector, check continuity between rack mounted computer receptacle bottom plug pins 35, 25, and 45, and servo motor connector pins B, D, and Y respectively.	Repair wiring as necessary.
	(2) Check for no continuity between bottom plug pins 34, 44, and 24, and servo connector pins A, C, and Z.	If continuity replace engage switch.
	(3) Manually hold auto throttle lever in engage position. Repeat step (2) checking for continuity.	If no continuity replace switch or repair wiring as necessary.

Possible Causes	Isolation Procedure	Correction
C. AUTO THROTTLE OFF WARNING LIGHTS DO NOT OPERATE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Warning light or wiring defective.	Press instrument failure monitor test switch.	If lights come on repair wiring, if not replace lights.
D. AUTO THROTTLE ENGAGES PROPERLY, THROTTLES DO NOT RESPOND		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Servo motor defective.	Perform computer self-test procedure steps (2) and (14 through 19).	Replace servo motor.
(3) Airspeed error selector switch defective.	Disconnect captain's and first officer's IAS indicator electrical connector. Remove computer. With airspeed error selector switch in captain position, check for continuity between computer rack mounted receptacle top plug pins 31 and 32 and captain's indicator connector pins 8 and 9 respectively, and no continuity between pins 31 and 32 and first officers indicator connector pins 8 and 9 respectively. Repeat above procedure with switch at first officers position using first officer's indicator connector.	Replace switch or repair wiring as necessary.
(4) IAS indicator defective.	Observe other indicator. Perform step (3).	Replace indicator or repair wiring as necessary.

Possible Causes	Isolation Procedure	Correction
E. THROTTLE LEVERS MOVE IN WRONG DIRECTION		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Airspeed error selector switch defective.	Perform step D.(3).	
(3) IAS indicator defective.	Perform step D.(4).	
(4) Engage switch or wiring defective.	Perform step B.(3).	
F. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary (see Chapter 76).
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
G. AUTO THROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

Possible Causes	Isolation Procedure	Correction
H. THROTTLE LEVERS DO NOT STOP AT UPPER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Maximum authority switch defective.	Remove computer. Check for continuity between rack mounted computer receptacle bottom plug pins 5 and 6. Slowly advance throttles. Continuity should break at 3 13/16 (±29/64) inches forward of aft stop.	Replace or adjust switch as necessary.
I. THROTTLE LEVERS DO NOT STOP AT LOWER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Minimum authority switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pins 16 and 12 (pins 14, 15, and 16 are common). While checking continuity slowly retard throttles. Continuity should break at 1 (±1/16) inches forward of aft stop. Repeat procedure using pins 16 and 13.	Replace or adjust switch as necessary.
J. FAST/SLOW INDICATOR DOES NOT FUNCTION PROPERLY		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Fast/slow pointer bias relay defective.	Check for 28 vdc at relay terminal X1.	If 28 vdc is present, replace relay.

Possible Causes	Isolation Procedure	Correction
J. FAST/SLOW INDICATOR DOES NOT FUNCTION PROPERLY (Continued)		
(3) Attitude director indicator defective.	Observe other indicator.	Replace defective indicator.
(4) IAS indicator defective.	See isolation procedure D.(3).	
K. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle bottom plug pins 22, 32, and 42, and position sensor connector pins 5, 4, and 3 respectively.	Replace sensor or repair wiring as necessary.



Auto Throttle System -- Schematic
(Airplanes N8070U-N8099U)
Figure 101 (Sheet 1)

Printed in U.S.A

AUTO THROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting the auto throttle system requires proper operation of the auto throttle interlock and the vertical gyro systems. The throttles should be rigged and in working order, and the elevator trailing edge should be at neutral position, 10 (±3/16) inches below marked rivet on the left side of the tail cone.

B. Auto throttle trouble shooting is performed using the captain's controls and indicators. Tests performed at the captain's flight station are primarily system tests and do not alone determine failure of a particular component. Troubles involving throttle motions and airplane dynamics may not be detected during ground check and the area of failure may have to be determined by process of elimination.

2. Tools and Equipment Required

A. A multimeter, Simpson model 260 or equivalent, is required to perform voltage and continuity checks.

3. Trouble Shooting Procedures

Possible Causes	Isolation Procedure	Correction
A. AUTO THROTTLE SYSTEM WILL NOT ENGAGE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace auto throttle computer.
(2) Quick disconnect switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pin 10 and top plug pin 38. No continuity indicates open quick disconnect switch or wiring.	Replace quick disconnect switch or repair wiring as necessary.

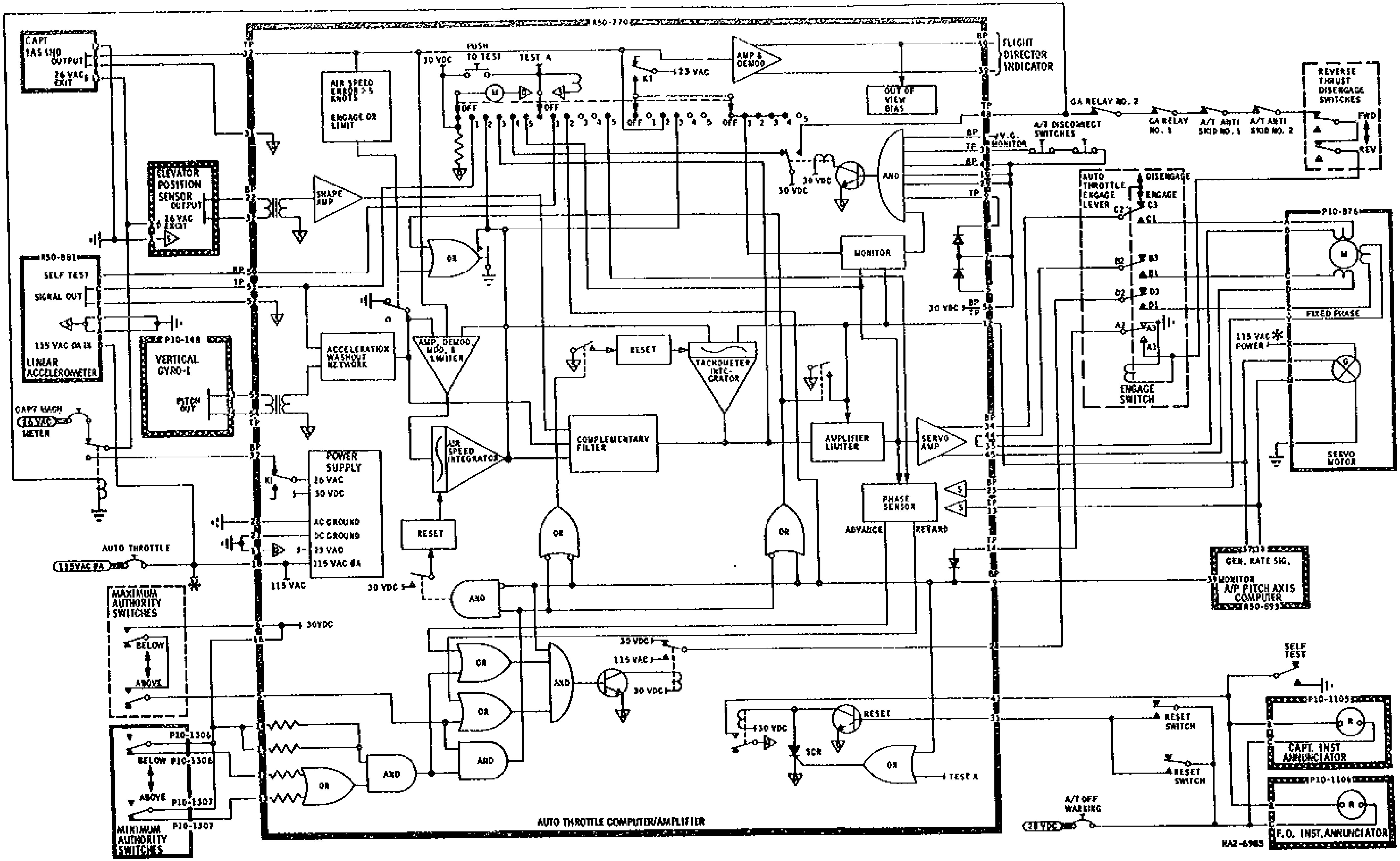
Possible Causes	Isolation Procedure	Correction
A. AUTO THROTTLE SYSTEM WILL NOT ENGAGE (Continued)		
(3) Disengage solenoid defective.	Check for 28vdc at solenoid terminal X1 (throttle levers in mid-quad position).	If 28vdc is present replace solenoid; if not remove computer. Check continuity between X1 and computer receptacle rack mounted top plug pin 48. Repair as necessary.
B. AUTO THROTTLE LEVER WILL NOT HOLD IN ENGAGE POSITION		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Servo motor defective.	Rotate self-test selector switch to position 4. Self test meter should indicate below yellow range within 20 seconds. Press and hold press-to-test switch, meter should indicate in yellow range within 30 seconds.	Replace servo motor.
(3) Engage switch defective or wiring defective.	(1) Remove computer, disconnect servo motor electrical connector, check continuity between rack mounted computer receptacle bottom plug pins 35, 25, and 45, and servo motor connector pins B, D, and Y respectively.	Repair wiring as necessary.
	(2) Check for no continuity between bottom plug pins 34, 44, and 24, and servo connector pins A, C, and Z.	If continuity replace engage switch.

Possible Causes	Isolation Procedure	Correction
B. AUTO THROTTLE LEVER WILL NOT HOLD IN ENGAGE POSITION (Continued)		
(3) (Continued)	(3) Manually hold auto throttle lever in engage position. Repeat step (2) checking for continuity.	If no continuity replace switch or repair wiring as necessary.
C. AUTO THROTTLE OFF WARNING LIGHTS DO NOT OPERATE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Warning light or wiring defective.	Press instrument failure monitor test switch.	If lights come on repair wiring, if not replace lights.
D. AUTO THROTTLE ENGAGES PROPERLY, THROTTLES DO NOT RESPOND		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Servo motor defective.	Perform computer self-test procedure steps (2) and (14 through 19).	Replace servo motor.
(3) Airspeed error selector switch defective.	Disconnect captain's and first officer's IAS indicator electrical connector. Remove computer. With airspeed error selector switch in captain position, check for continuity between computer rack mounted receptacle top plug pins 31 and 32 and captain's indicator connector pins 8 and 9 respectively, and no continuity between pins 31 and 32 and first officers indicator connector pins 8 and 9 respectively.	Replace switch or repair wiring as necessary.

Possible Causes	Isolation Procedure	Correction
D. AUTO THROTTLE ENGAGES PROPERLY, THROTTLES DO NOT RESPOND (Continued)		
(3) (Continued)	Repeat above procedure with switch at first officers position using first officer's indicator connector	
(4) IAS indicator defective.	Observe other indicator. Perform step (3).	Replace indicator or repair wiring as necessary.
E. THROTTLE LEVERS MOVE IN WRONG DIRECTION		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Airspeed error selector switch defective.	Perform step D(3).	
(3) IAS indicator defective.	Perform step D(4).	
(4) Engage switch or wiring defective.	Perform step B(3).	
F. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary (see Chapter 76).
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.

Possible Causes	Isolation Procedure	Correction
G. AUTO THROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
H. THROTTLE LEVERS DO NOT STOP AT UPPER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Maximum authority switch defective.	Remove computer. Check for continuity between rack mounted computer receptacle bottom plug pins 5 and 6. Slowly advance throttles. Continuity should break at 3 13/16 (±29/64) inches forward of aft stop.	Replace or adjust switch as necessary.
I. THROTTLE LEVERS DO NOT STOP AT LOWER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Minimum authority switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pins 16 and 12 (pins 14, 15, and 16 are common). While checking continuity slowly retard throttles. Continuity should break at 1 (±1/16) inches forward of aft stop. Repeat procedure using pins 16 and 13.	Replace or adjust switch as necessary.

Possible Causes	Isolation Procedure	Correction
J. FAST/SLOW INDICATOR DOES NOT FUNCTION PROPERLY		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Fast/slow pointer bias relay defective.	Check for 28 vdc at relay terminal X1.	If 28 vdc is present, replace relay.
(3) Attitude director indicator defective.	Observe other indicator.	Replace defective indicator.
(4) IAS indicator defective.	See isolation procedure D(3).	
K. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle bottom plug pins 22, 32, and 42, and position sensor connector pins 5, 4, and 3 respectively.	Replace sensor or repair wiring as necessary.



Auto Throttle System -- Schematic
Figure 101

AUTOTHROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting procedures consist primarily of isolation of faulty components. In the case of autothrottle electronic components, this can sometimes be accomplished by self-test.

B. A throough knowledge of the interrelationship of components is essential for meaningful trouble shooting. For this reason, an autothrottle and associated system interface simplified schematic is contained in this section.

C. A Trouble Shooting Index is provided in paragraph 3. This is to be utilized as an aid to isolate particular problem areas. When a problem arises, isolate the problem area, then use the referenced logic diagram to isolate the faulty component, or defective wiring.

D. Refer to paragraph 4 for location of circuit breakers that have a direct bearing on the operation of the autothrottle and associated systems.

E. Standard electrical voltages are given in the following procedures, however it is to be understood that a 10% tolerance is permissible unless otherwise stated.

2. Tools and Equipment Required

A. The following equipment or suitable substitute may be required during trouble shooting procedures:

Item	Name	Number	Manufacturer	Use
A	Volt-Ohm Meter	Model 260	Simpson	Used to read ac and dc voltages, and to check circuit continuity, and to measure resistance.

3. Trouble Shooting Index - Autothrottle System

A. The following table lists the malfunctions that are covered in this trouble shooting procedure:

	Malfunction	Figure No.
(1)	Autothrottle Off Warning Lights Remain On	103
(2)	Autothrottle Off Warning Lights Do Not Come On	104
(3)	Autothrottle System Will Not Engage	105
(4)	Throttle Levers Drive Beyond Electrical Stops	106

4. Circuit Breakers

A. Open the following circuit breakers:

CIRCUIT BREAKER	LOCATION
ALL FUEL BOOST PUMP	AC BUSSES 1, 2, 3, & 4
ENGINE STARTERS	BATTERY BUS
IGNITION PWR SUPPLY	BATTERY BUS
IGNITION PWR SUPPLY CONT	BATTERY BUS

B. Close the following circuit breakers:

CIRCUIT BREAKER	LOCATION
AUTOTHROTTLE 115 VAC	RADIO BUS 3
AUTOTHROTTLE OFF WARN LT	RADIO BUS 2
ANTI-SKID SYSTEM	DC BUSSES 1 & 4
GROUND SPOILER CONTROL	AC BUS 4
VERTICAL GYRO 1	LEFT AC EMER BUS

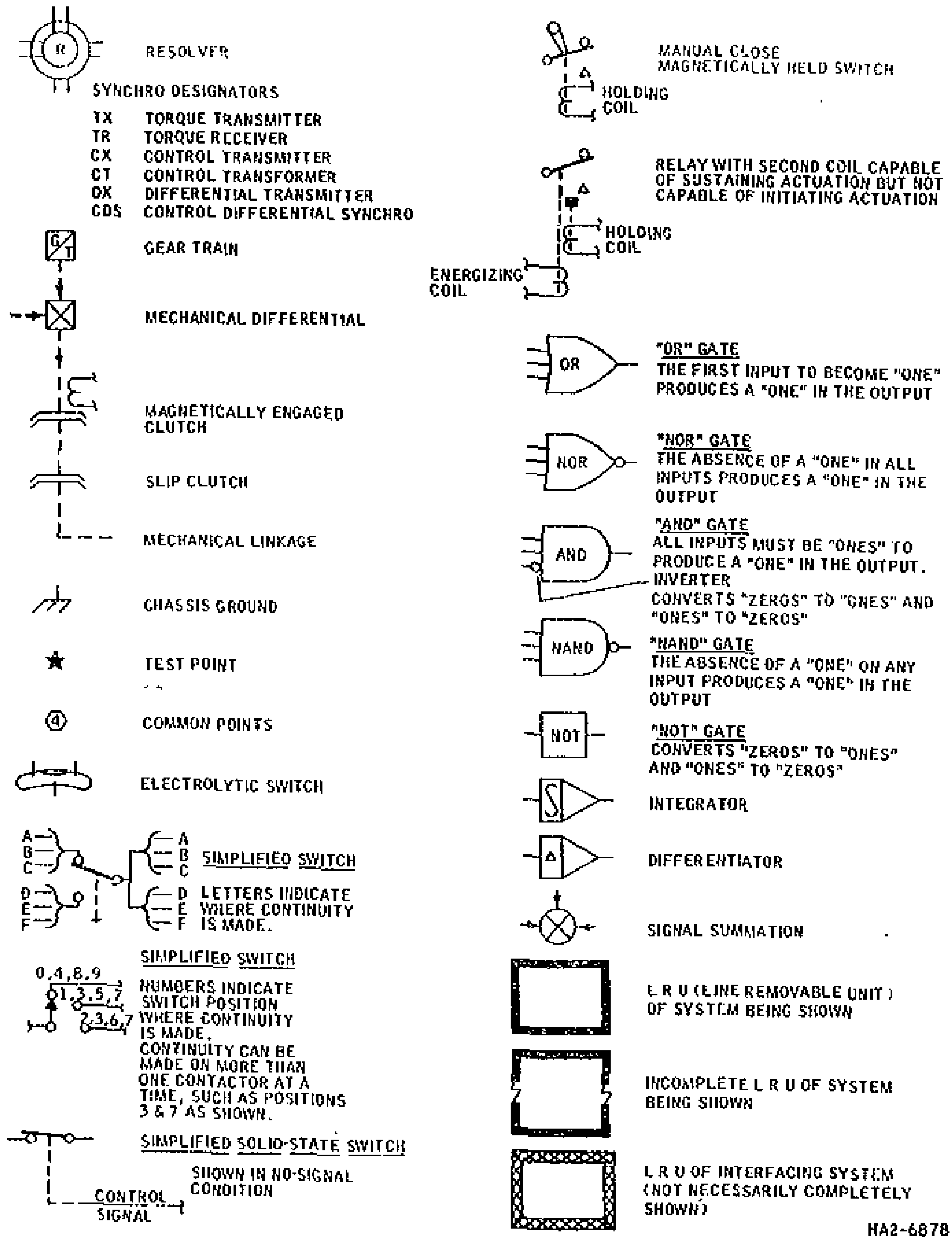
CIRCUIT BREAKER	LOCATION
AUX VERTICAL GYRO	RIGHT & LEFT AC EMER BUSSES
VERT GYRO TRANSFER	RIGHT DC EMER BUS
GO AROUND 1 & 2	RADIO BUSSES 2 & 3
RADIO BUS 2 LOAD MONITOR	RADIO BUS 2
RADIO BUS 3 LOAD MONITOR	RADIO BUS 3

5. Additional Throttle Response Problems

Possible Causes	Isolation Procedure	Correction
A. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective	Perform computer self-test procedure (see 22-30-1)	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle P10-770 bottom plug pins 22 & 32, and position sensor connector pins 5 & 4, respectively.	Replace sensor or repair wiring as necessary.

Possible Causes	Isolation Procedure	Correction
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary.
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
C. AUTOTHROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

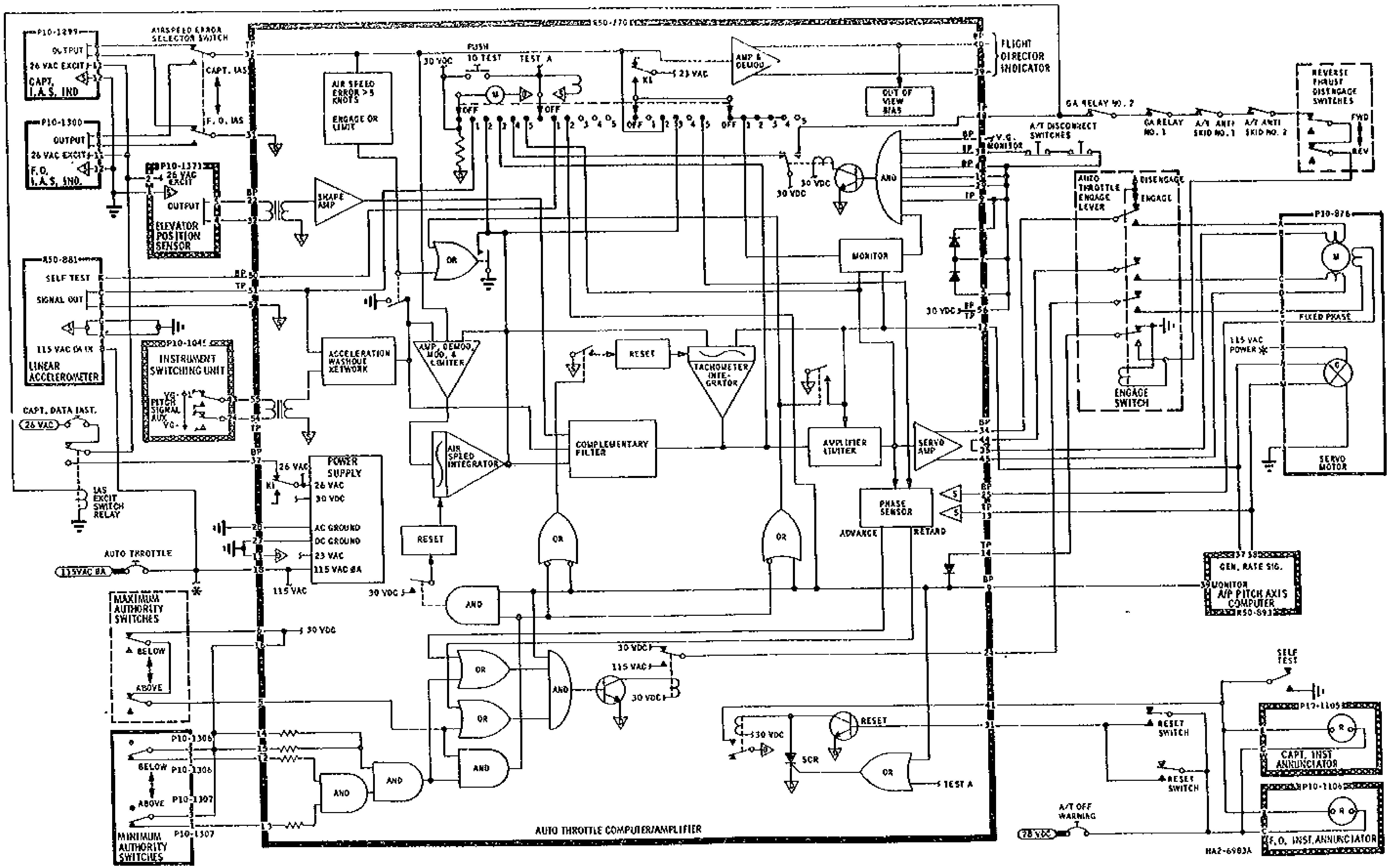
SCHEMATIC SYMBOLS NOT COVERED BY ATA 100



Schematic Symbols
Figure 101

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Autothrottle System -- Schematic
Figure 102

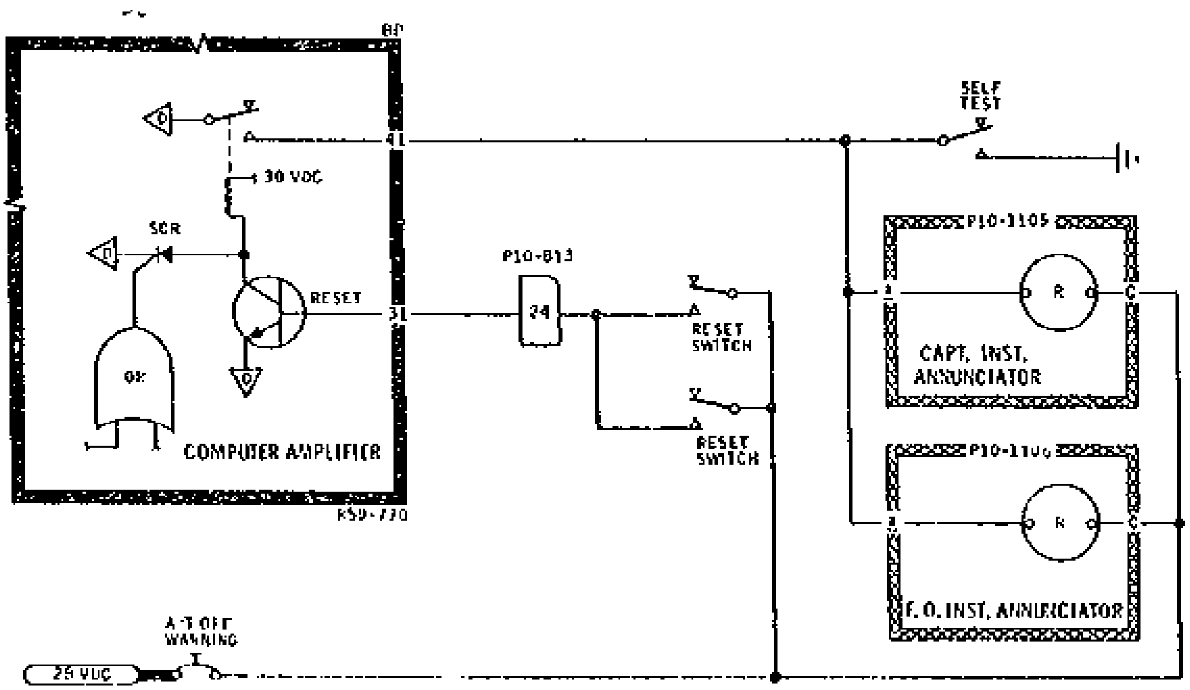
AUTOTHROTTLE OFF WARNING LIGHTS REMAIN ON

PROBABLE FAULT

1. AUTOTHROTTLE COMPUTER.
2. AUTOTHROTTLE RESET SWITCHES.
3. DEFECTIVE WIRING.

PRESS AND RELEASE AUTOTHROTTLE RESET SWITCHES.
- LIGHT REMAINS ON

WITH AUTOTHROTTLE RELEASE SWITCHES OPEN. MEASURE 0 VDC AT P10-813 PIN 24 TO GROUND.
- VOLTAGE: REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE RESET SWITCHES.
- 0 VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKER. LIGHT SHOULD BE OUT
  - LIGHT REMAINS ON: REPLACE OR REPAIR DEFECTIVE WIRING. (R50-770 PIN 41 THROUGH FAILURE WARNING ANNUNCIATORS). CHECK FOR SHORT CIRCUITS TO GROUND.
  - LIGHT GOES OUT: REPLACE AUTOTHROTTLE COMPUTER.



HA1-7219

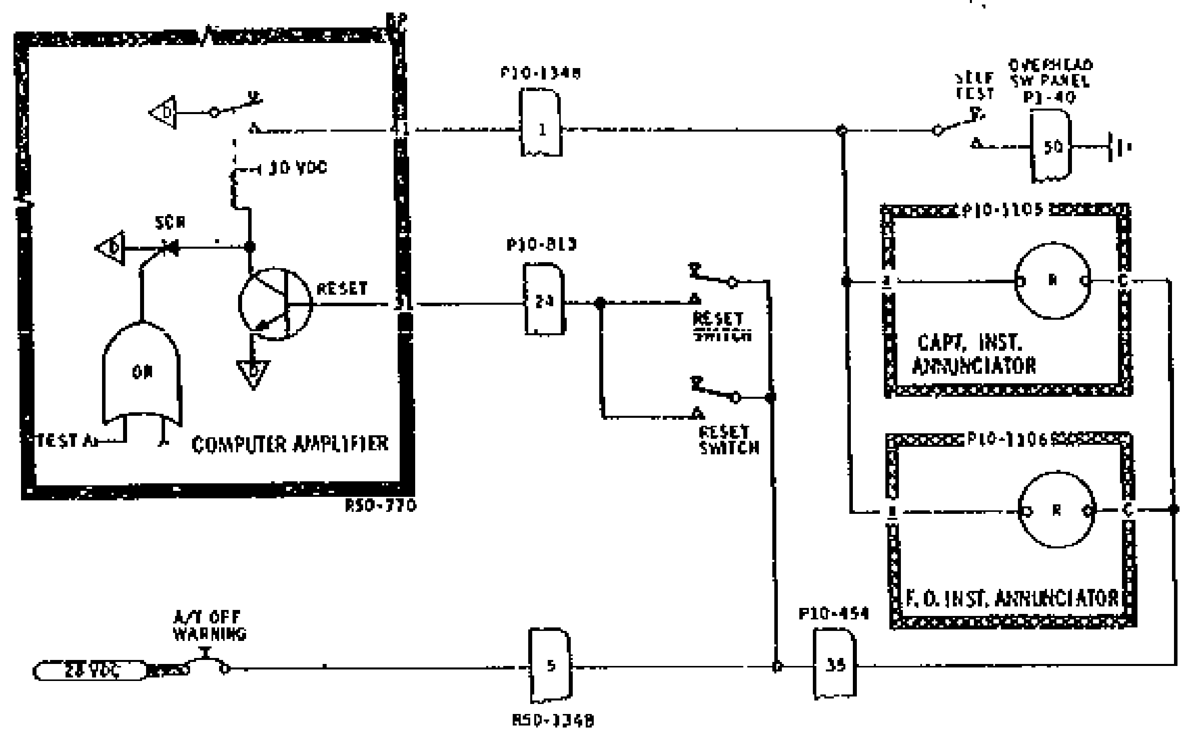
Autothrottle Off Warning Lights Remain On
Figure 103

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AUTOTHROTTLE OFF WARNING LIGHTS DO NOT LIGHT

PROBABLE FAULT

1. DEFECTIVE ANNUNCIATOR BULB
2. AUTOTHROTTLE COMPUTER.
3. AUTOTHROTTLE RESET SWITCHES.
4. SELF TEST SWITCH.
5. NAV INSTRUMENT FAILURE WARNING ANNUNCIATOR.



WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PLACE NAV/INST ANNUNCIATOR DIMMING UNIT TO THE BRIGHT POSITION. PRESS SELF TEST SWITCH ON OVERHEAD SWITCH PANEL. AUTOTHROTTLE ANNUNCIATOR SHOULD COME ON.

- LIGHT DOES NOT COME ON IN SELF TEST.
  - REPLACE AUTOTHROTTLE ANNUNCIATOR BULB AND PERFORM ABOVE SELF TEST.
    - LIGHT STILL DOES NOT COME ON.
      - CHECK CONTINUITY FROM P1-40 PIN 50 TO GROUND.
        - NO CONTINUITY → REPLACE OR REPAIR DEFECTIVE WIRING CHECK GROUND FOR LOOSE OR DIRTY CONNECTION.
        - CONTINUITY → CHECK FOR 28 VDC AT R50-1348 PIN 5.
          - NO VOLTAGE → REPLACE CIRCUIT BREAKER
          - VOLTAGE → CHECK FOR 28 VDC AT P10-454 PIN 35
            - NO VOLTAGE → REPAIR OR REPLACE DEFECTIVE WIRING.
            - VOLTAGE → DEPRESS AND HOLD SELF TEST SWITCH. MEASURE 28 VDC AT P1-40 PIN 50.
              - NO VOLTAGE → REPLACE SELF TEST SWITCH.
              - VOLTAGE → TROUBLE SHOOT ANNUNCIATORS. REPAIR OR REPLACE AS NECESSARY.
- LIGHT COMES ON IN SELF TEST ONLY.
  - WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PRESS AND RELEASE INSTRUMENT WARNING RESET SWITCHES. MEASURE ZERO VDC AT P10-813 PIN 24 TO GROUND.
    - VOLTAGE → REPLACE OR REPAIR DEFECTIVE WIRING AND/OR RESET SWITCHES.
    - ZERO VOLTAGE → OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKERS. JUMPER R50-770BP PIN 41 TO GROUND.
      - LIGHT COMES ON → REPLACE AUTOTHROTTLE COMPUTER
      - LIGHT DOES NOT COME ON → REPLACE OR REPAIR DEFECTIVE WIRING.

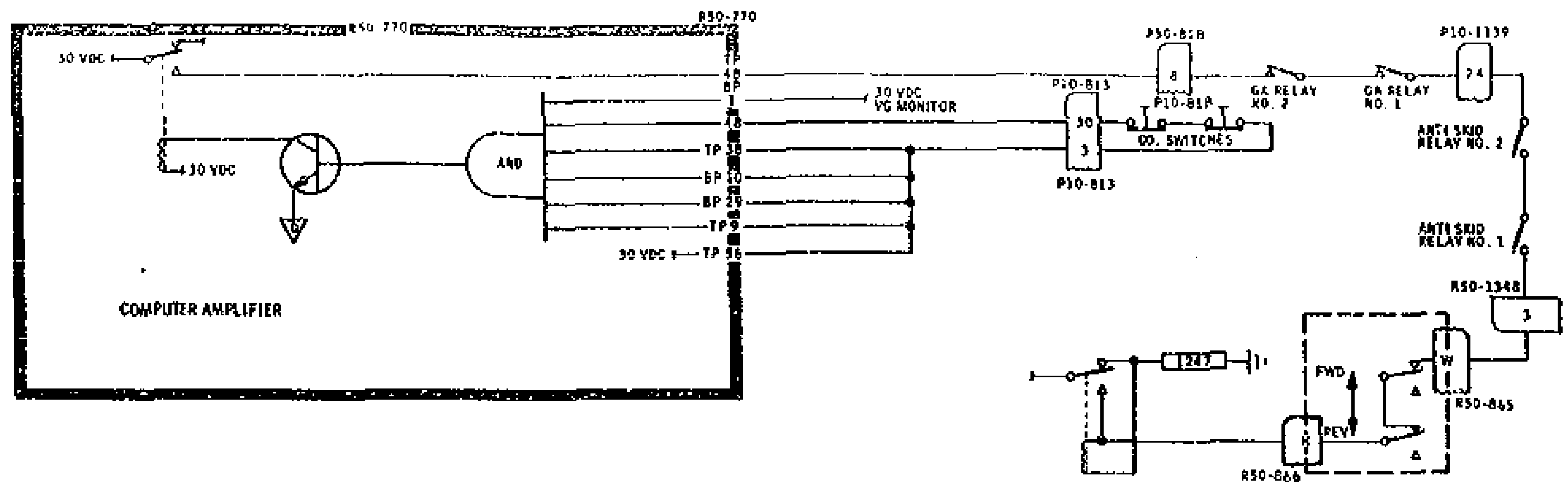
NOTE: IF SYSTEM CHECKS OUT AND LIGHT STILL DOES NOT COME ON, NAV. INST. DIMMER SWITCH SHOULD BE CHECKED.

HA2-7220

Autothrottle Off Warning Lights Do Not Come On
Figure 104

AUTOTHROTTLE SYSTEM WILL NOT ENGAGE (AUTOTHROTTLE LEVER REMAINS LOCKED IN THE DISENGAGE POSITION)

PROBABLE FAULT
1. AUTOTHROTTLE ENGAGE SWITCH.
2. AUTOTHROTTLE COMPUTER.
3. GO-AROUND MODE RELAYS.
4. AUTOTHROTTLE ANTI-SKID RELAYS.
5. THROTTLE DISENGAGE SWITCHES.

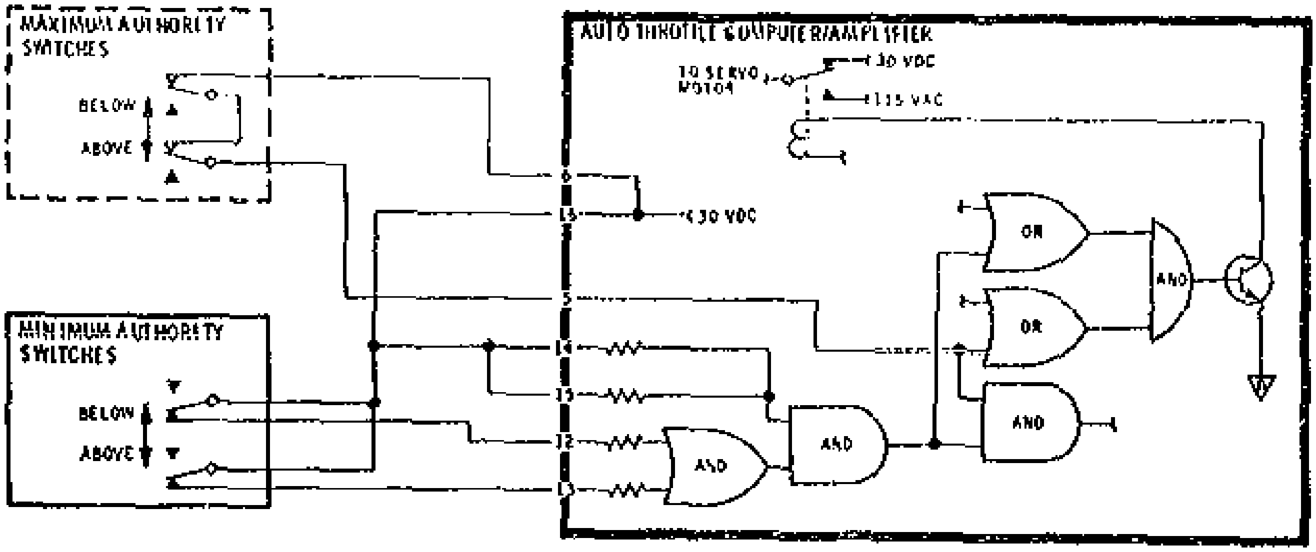


CLOSE ALL AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS.

CHECK 28 VDC AT R50-1348, PIN 3
- NO VOLTAGE: CHECK 28 VDC AT P10-1139, PIN 24.
  - VOLTAGE: REPAIR OR REPLACE ANTISKID SWITCHES AND/OR ASSOCIATED WIRING.
  - NO VOLTAGE: CHECK 28 VDC AT P10-818 PIN 8.
    - VOLTAGE: REPAIR OR REPLACE G/A SWITCHES AND/OR ASSOCIATED WIRING.
    - NO VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS, AND REMOVE COMPUTER AMPLIFIER. CHECK CONTINUITY BETWEEN P10-770 PIN 48(TP), AND P10-818 PIN 8.
      - CONTINUITY: VERIFY ENGAGE LOGIC CIRCUITS AS FOLLOWS:
        ON COMPUTER AMPLIFIER CHECK CONTINUITY BETWEEN THE FOLLOWING POINTS:
        1. R50-770 PIN 56(BP) TO PIN 9(TP).
        2. R50-770 PIN 56(BP) TO PIN 29(BP).
        3. R50-770 PIN 56(BP) TO PIN 10(BP).
        4. R50-770 PIN 56(BP) TO PIN 38(TP).
        5. R50-770 PIN 56(BP) TO PIN 48(BP).
        - CONTINUITY: CLOSE AUTO THROTTLE AND ASSOCIATED CIRCUIT BREAKERS AND CHECK 28 VDC AT P10-770 PIN 1 (BP). (VG MONITOR)
          - VOLTAGE: CHECK CONTINUITY BETWEEN P10-770 PIN 38(TP) AND PIN 48(BP). (THIS CHECKS OUT QUICK DISCONNECT SWITCHES).
            - CONTINUITY: REPLACE COMPUTER AMPLIFIER
            - NO CONTINUITY: REPAIR OR REPLACE QUICK DISCONNECT SWITCHES AND/OR ASSOCIATED WIRING AS NECESSARY.
          - NO VOLTAGE
        - NO CONTINUITY: REPLACE COMPUTER AMPLIFIER
      - NO CONTINUITY: REPAIR OR REPLACE DEFECTIVE WIRING
- VOLTAGE: CHECK 28 VDC AT R50-866 PIN H.
  - VOLTAGE: REMOVE WIRE Q503 AX 24N FROM GROUND STUD L247, (RADIO RACK SHELF NO. 2) AND CHECK 28 VDC FROM WIRE TERMINAL TO GROUND.
    NOTE: IN EITHER CASE REPAIR OR REPLACE DEFECTIVE WIRING, AND/OR ENGAGE RELAY.
  - NO VOLTAGE: REPAIR OR REPLACE REVERSE THRUST SWITCHES AND ASSOCIATED WIRING.

KA2-7321

Autothrottle System Will Not Engage
Figure 105



WITH AUTO THROTTLE ENGAGED, THROTTLE LEVERS DRIVE BEYOND ELECTRICAL STOPS.

PROBABLE CAUSES:

MINIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

MAXIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

IN WHICH DIRECTION DO THROTTLES DRIVE BEYOND LIMITS?

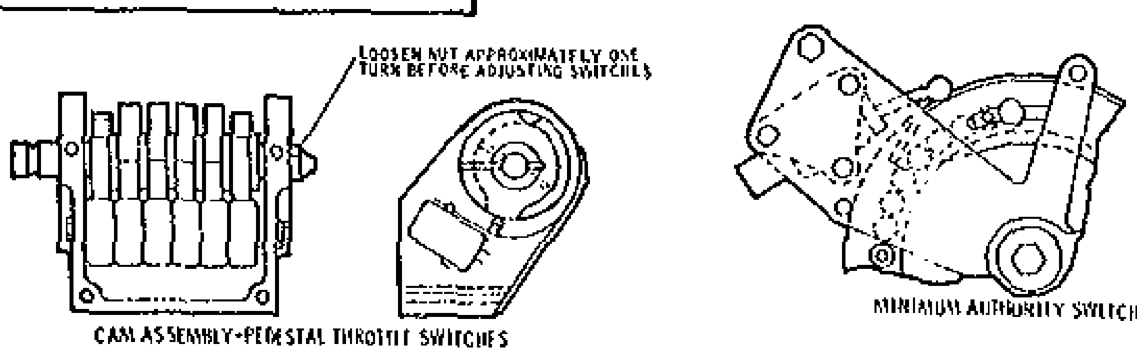
MAXIMUM	MINIMUM

MAXIMUM:

1. POSITION NUMBER 2 AND NUMBER 3 THROTTLE LEVER 3 13/16 ± 1/16 INCHES FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLER MOVES FROM LOW TO HIGH PORTION OF CAM.
3. TORQUE CAM SHAFT RETAINING NUT TO 50 INCH POUNDS AND SECURE WITH COTTER KEY.
4. VERIFY THAT SWITCHES DEACTUATE AT 3 13/16 INCHES FORWARD OF AFT STOP WHILE THROTTLES ARE MOVING IN POWER ON DIRECTION.

MINIMUM:

1. POSITION NUMBER 1 AND NUMBER 4 THROTTLE LEVER 1 INCH FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLERS MOVE FROM HIGH TO LOW PORTION OF CAM.
3. VERIFY THAT SWITCHES DEACTUATE 1 ± 1/16 INCHES FROM AFT STOP WHILE THROTTLE LEVERS ARE MOVING IN POWER OFF DIRECTION.



Throttle Levers Drive Beyond Electrical Stops
Figure 106

AUTOTHROTTLE - TROUBLE SHOOTING

1. General

   A. Trouble shooting procedures consist, primarily, of isolation of faulty components. In the case of autothrottle electronic components, this sometimes can be accomplished by means of self-test.

   B. A thorough knowledge of the interrelationship of components is essential for meaningful trouble shooting. For this reason, an autothrottle and associated system interface simplified schematic is contained in this section.

   C. A Trouble Shooting Index is provided in item 3. This is to be utilized as an aid to isolate particular problems. Find the problem, then use the referenced logic diagram to isolate the faulty component or defective wiring.

   D. Refer to item 4 for location of circuit breakers that have a direct bearing on operation of the autothrottle and associated systems.

   E. Standard electrical voltages are given in the procedures. However, it is to be understood that a 10% tolerance is permissible, unless otherwise stated.

2. Tools and Equipment Required

   A. The following equipment or equivalent substitutes may be required during trouble shooting procedures.

Item	Name	Number	Manufacturer	Use
A	Volt-Ohm-Meter	Model 260	Simpson	Take ac and dc voltage readings, and to check circuit continuity. Measure resistance readings.

3. Trouble Shooting Index - Autothrottle System

A. The following table lists the malfunctions that are covered in this trouble shooting procedure.

Malfunction	Figure No.
(1) Autothrottle Off Warning Lights Remain On	101
(2) Autothrottle Off Warning Does Not Light	102
(3) Autothrottle System Will Not Engage (Autothrottle Lever Remains Locked In The Disengage Position.)	103
(4) Autothrottle Engages Properly. Autothrottle Levers Do Not Follow Up To Center Fast-Slow Indicator	104

4. Circuit Breakers

A. Open the following circuit breakers:

Circuit Breaker	Location
(3) Main Tank Fuel Boost Pump 115 VAC	AC BUS 1
(3) Main Tank Fuel Boost Pump 115 VAC	AC BUS 2
(3) Main Tank Fuel Boost Pump 115 VAC	AC BUS 3
(3) Main Tank Fuel Boost Pump 115 VAC	AC BUS 4
(12) Alternate Tank Fuel Boost Pump 115 VAC	AC BUSES 1, 2, 3, 4
(12) Main Tank Fuel Feed Pump 115 VAC	AC BUSES 1, 2, 3, 4
(6) Center Wing Aux Tank Fuel Boost Pumps 115 VAC	AC BUSES 2, 3
All other Fuel System circuit breakers.	
(4) Continuous Engine Ignition 115 VAC	AC BUSES 1, 2, 3, 4
Ground Control Relays 115 VAC	Left AC BUS 2, Right AC BUS 3
Anti Skid System	DC BUSES 1, 4

B. Close the following circuit breakers:

Circuit Breaker	Location
Speed Command 115 VAC	RADIO BUS 3
Autothrottle 115 VAC	RADIO BUS 3
Vertical Gyro-1	Left AC EMER BUS
Aux Vertical Gyro (2)	Left and Right AC EMER BUS
Horizon Display (Captain's, First Officer's)	Left and Right AC EMER BUS
Flt Director-1 Command (2)	AC, DC RADIO BUS 2
Flt Director-2 Command (2)	AC, DC RADIO BUS 3
Navigation Inst XMFR-1, -2	AC RADIO BUS 2, 3
Autothrottle Off Warning	DC RADIO BUS 2
Go Around-1, -2	DC RADIO BUS 2, 3

SCHEMATIC SYMBOLS NOT COVERED BY ATA 100

RESOLVER

SYNCHRO DESIGNATORS

TX	TORQUE TRANSMITTER
TR	TORQUE RECEIVER
CX	CONTROL TRANSMITTER
CT	CONTROL TRANSFORMER
DX	DIFFERENTIAL TRANSMITTER
CDS	CONTROL DIFFERENTIAL SYNCHRO

GEAR TRAIN

MECHANICAL DIFFERENTIAL

MAGNETICALLY ENGAGED CLUTCH

SLIP CLUTCH

MECHANICAL LINKAGE

CHASSIS GROUND

TEST POINT

COMMON POINTS

ELECTROLYTIC SWITCH

A B C D E F

SIMPLIFIED SWITCH
LETTERS INDICATE WHERE CONTINUITY IS MADE.

SIMPLIFIED SWITCH

0,4,8,9 1,3,5,7 2,3,6,7

NUMBERS INDICATE SWITCH POSITION WHERE CONTINUITY IS MADE.
CONTINUITY CAN BE MADE ON MORE THAN ONE CONTACTOR AT A TIME, SUCH AS POSITIONS 3 & 7 AS SHOWN.

SIMPLIFIED SOLID-STATE SWITCH
SHOWN IN NO-SIGNAL CONDITION

CONTROL SIGNAL

MANUAL CLOSE MAGNETICALLY HELD SWITCH

HOLDING COIL

RELAY WITH SECOND COIL CAPABLE OF SUSTAINING ACTUATION BUT NOT CAPABLE OF INITIATING ACTUATION

HOLDING COIL

ENERGIZING COIL

OR

"OR" GATE
THE FIRST INPUT TO BECOME "ONE" PRODUCES A "ONE" IN THE OUTPUT

NOR

"NOR" GATE
THE ABSENCE OF A "ONE" IN ALL INPUTS PRODUCES A "ONE" IN THE OUTPUT

AND

"AND" GATE
ALL INPUTS MUST BE "ONES" TO PRODUCE A "ONE" IN THE OUTPUT.

INVERTER
CONVERTS "ZEROS" TO "ONES" AND "ONES" TO "ZEROS"

NAND

"NAND" GATE
THE ABSENCE OF A "ONE" ON ANY INPUT PRODUCES A "ONE" IN THE OUTPUT

NOT

"NOT" GATE
CONVERTS "ZEROS" TO "ONES" AND "ONES" TO "ZEROS"

INTEGRATOR

DIFFERENTIATOR

SIGNAL SUMMATION

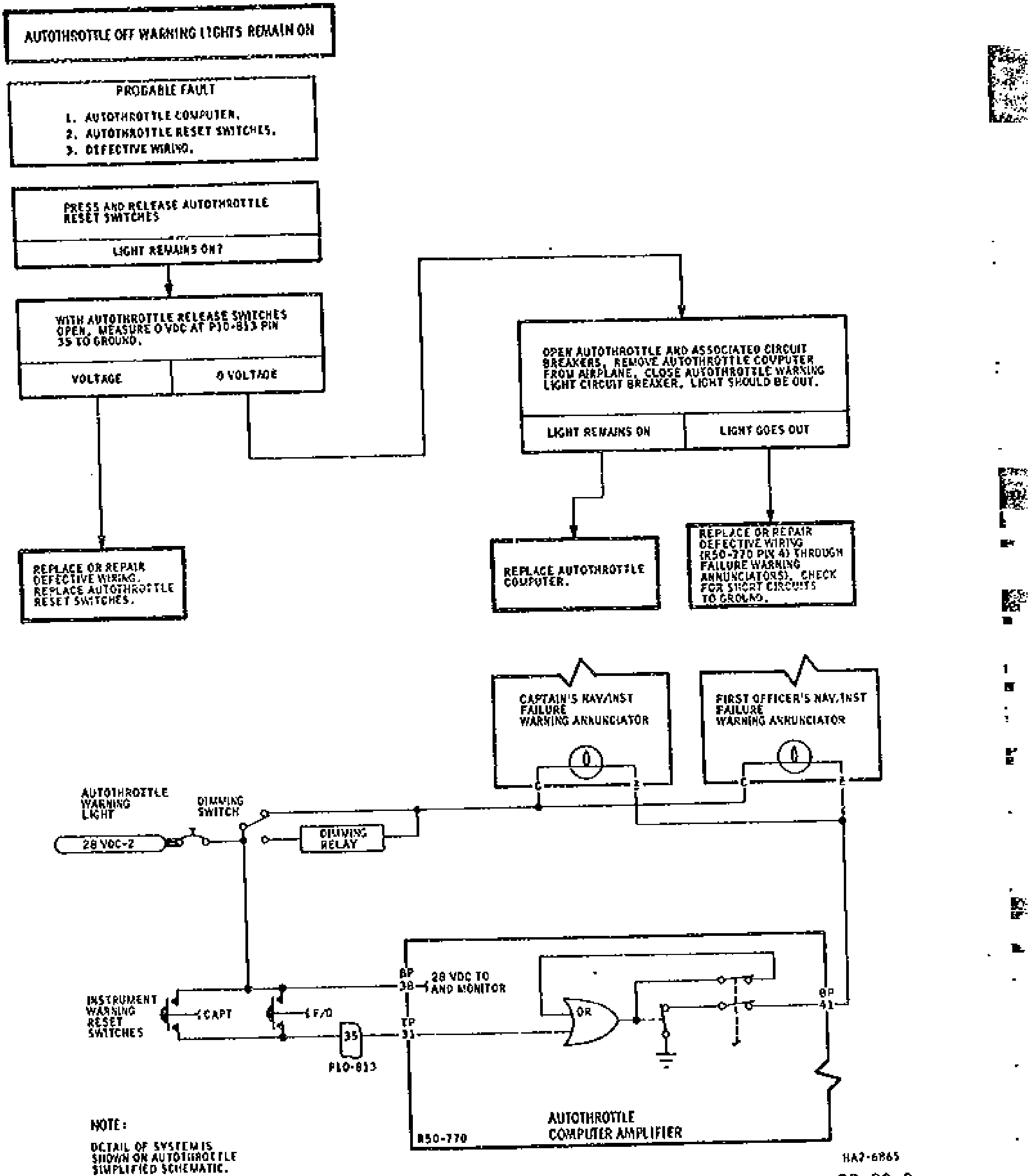
L R U (LINE REMOVABLE UNIT) OF SYSTEM BEING SHOWN

INCOMPLETE L R U OF SYSTEM BEING SHOWN

L R U OF INTERFACING SYSTEM (NOT NECESSARILY COMPLETELY SHOWN)

HA2-6878

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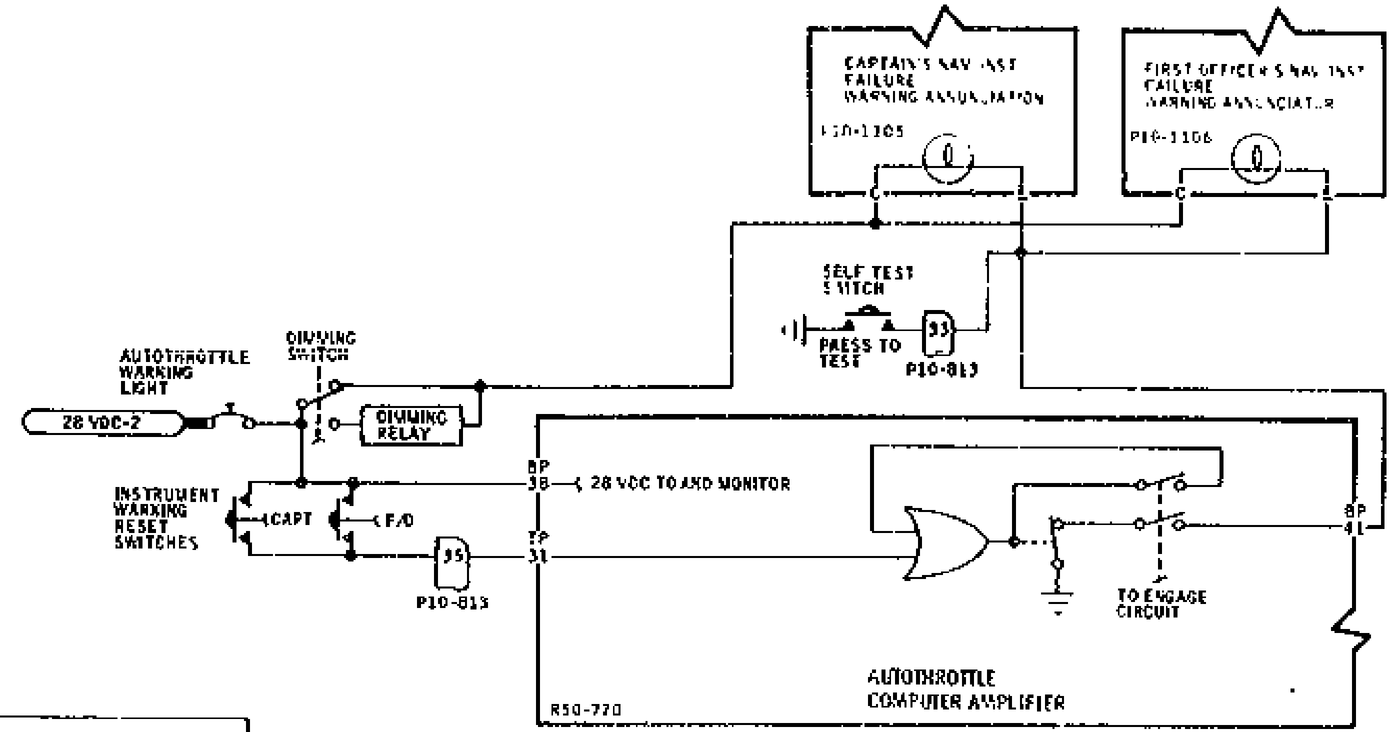
Autothrottle Off Warning Lights Remain On
Figure 101

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AUTOTHROTTLE OFF WARNING DOES NOT LIGHT

PROBABLE FAULT

1. DEFECTIVE ANNUNCIATOR BULB
2. AUTOTHROTTLE COMPUTER.
3. AUTHROTTLE RESET SWITCHES.
4. SELF TEST SWITCH
5. NAV INSTRUMENT FAILURE WARNING ANNUNCIATOR.



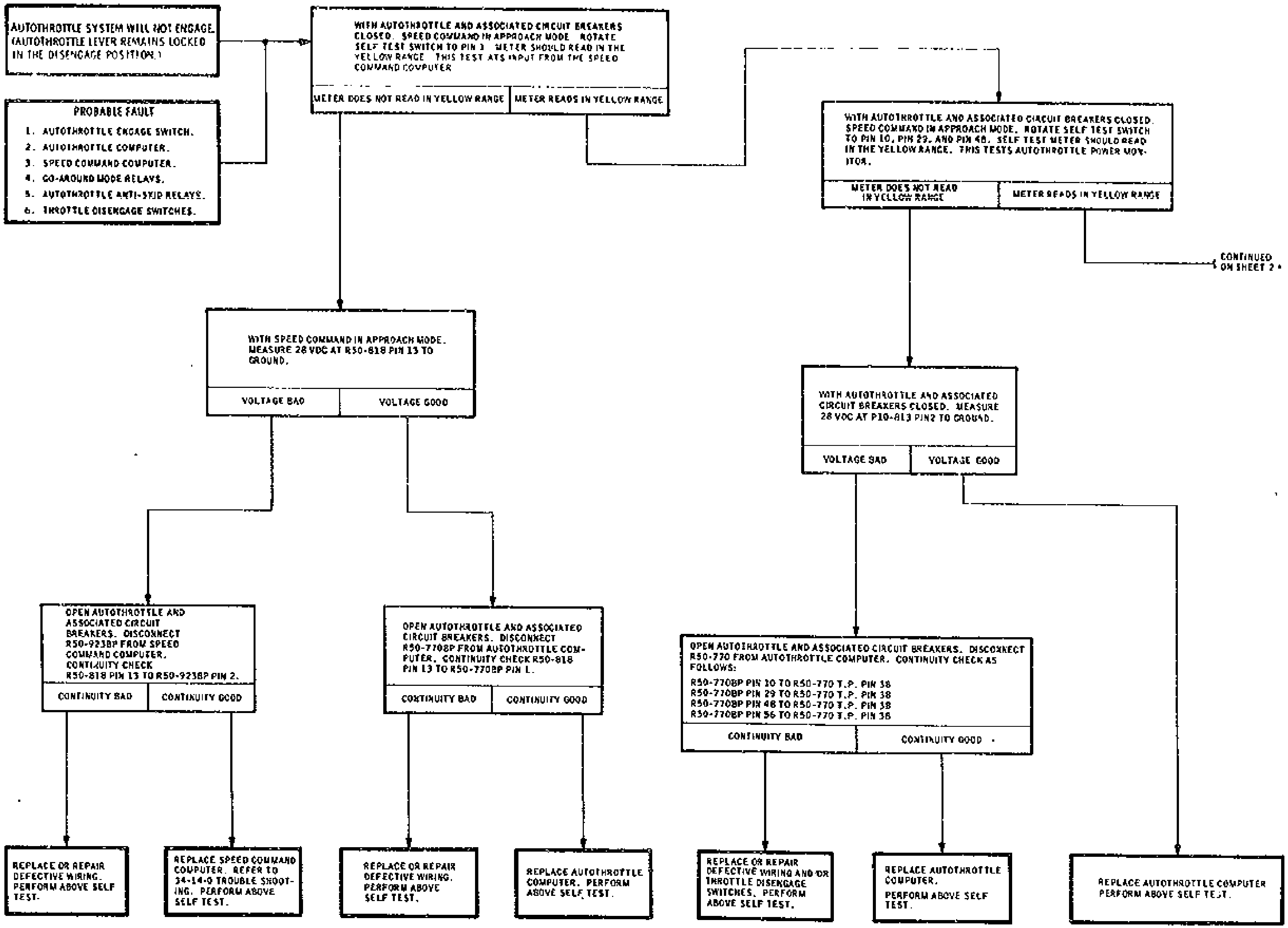
NOTE:
DETAIL OF SYSTEM IS SHOWN ON AUTOTHROTTLE SIMPLIFIED SCHEMATIC

WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PLACE NAV/INST ANNUNCIATOR DIMMING UNIT TO THE BRIGHT POSITION. PRESS SELF TEST SWITCH ON OVERHEAD SWITCH PANEL. AUTOTHROTTLE ANNUNCIATOR SHOULD COME ON GREEN.

- LIGHT DOES NOT COME ON IN SELF TEST.
  - REPLACE AUTOTHROTTLE ANNUNCIATOR BULB AND PERFORM ABOVE SELF TEST.
    - LIGHT STILL DOES NOT COME ON.
      - MEASURE 28 VDC AT P10-813 PIN 33 TO GROUND.
        - VOLTAGE GOOD: DID LIGHT COME ON. IF SO, REPLACE SELF TEST SWITCH.
        - VOLTAGE BAD: OPEN AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKERS. CONTINUITY CHECK P10-813 PIN 33 TO P10-1105, PIN 1 NAV/INST FAILURE WARNING ANNUNCIATOR.
          - CONTINUITY BAD: REPLACE OR REPAIR DEFECTIVE WIRING.
          - CONTINUITY GOOD: CONTINUE CONTINUITY CHECK TO POWER SOURCE. REPLACE OR REPAIR WIRES AS NECESSARY.
- LIGHT COMES ON IN SELF TEST ONLY.
  - WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PRESS AND RELEASE INSTRUMENT WARNING RESET SWITCHES. MEASURE ZERO VDC AT P10-813 PIN 35 TO GROUND.
    - VOLTAGE: REPLACE OR REPAIR DEFECTIVE WIRING AND/OR RESET SWITCHES.
    - ZERO VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKERS. JUMPER R50-770BP PIN 41 TO GROUND.
      - LIGHT COMES ON: REPLACE AUTOTHROTTLE COMPUTER.
      - LIGHT DOES NOT COME ON: REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE NAV INST DIMMING UNIT. REPLACE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKER.

HA2-6F66

Autothrottle Off Warning Does Not Light
Figure 102



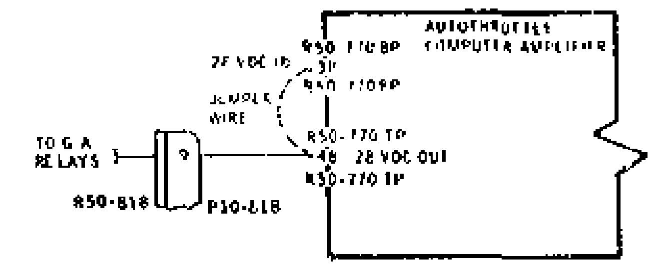
Autothrottle System Will Not Engage (Autothrottle Lever Remains Locked In The Disengage Position)
Figure 103 (Sheet 1)

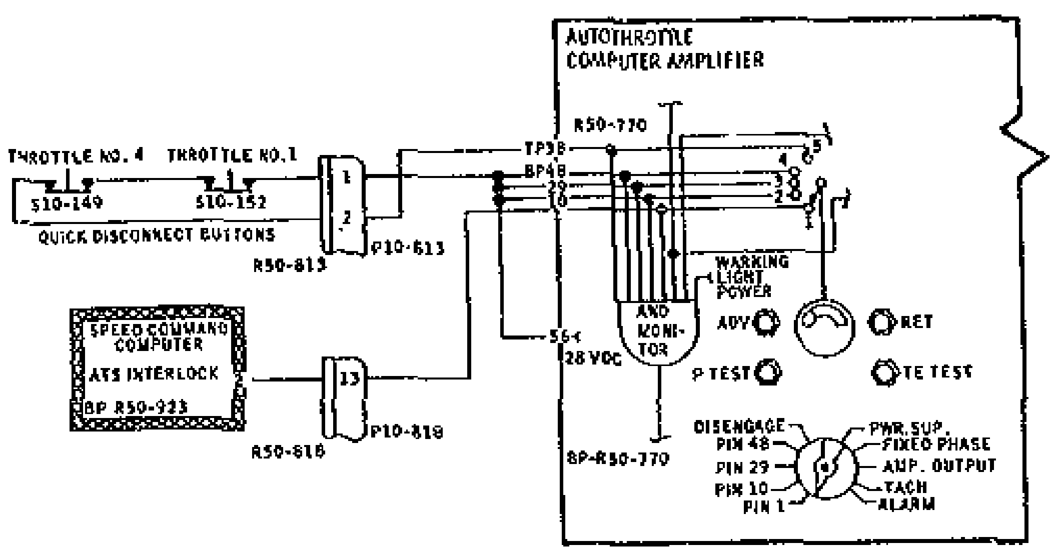
AUTOTHROTTLE SYSTEM WILL NOT ENGAGE (AUTOTHROTTLE LEVER REMAINS LOCKED IN THE DISENGAGE POSITION.) CONTINUED FROM SHEET 1

CONTINUED FROM SHEET 1

OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. DISCONNECT R50-770 TP AND R50-770 BP FROM AUTOTHROTTLE COMPUTER. PLACE JUMPER WIRE ON R50-770 TP PIN 48 TO R50-770 BP PIN 38. CLOSE AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. PLACE SPEED COMMAND IN APPROACH MODE, AND ATTEMPT TO ENGAGE THE AUTOTHROTTLE. REMOVE JUMPER WIRE.

- AUTOTHROTTLE ENGAGES → REPLACE AUTOTHROTTLE COMPUTER
- AUTOTHROTTLE DOES NOT ENGAGE → WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED, SPEED COMMAND IN APPROACH MODE. MEASURE 28 VDC AT P10-818 PIN 9 TO GROUND.
  - VOLTAGE GOOD → CONTINUED ON SHEET 3
  - VOLTAGE BAD → OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. DISCONNECT R50-770 TP FROM AUTOTHROTTLE COMPUTER. CONTINUITY CHECK R50-770 TP PIN 48 TO P10-818 PIN 9.
    - CONTINUITY BAD → REPLACE OR REPAIR DEFECTIVE WIRING.
    - CONTINUITY GOOD → REPLACE AUTOTHROTTLE COMPUTER.

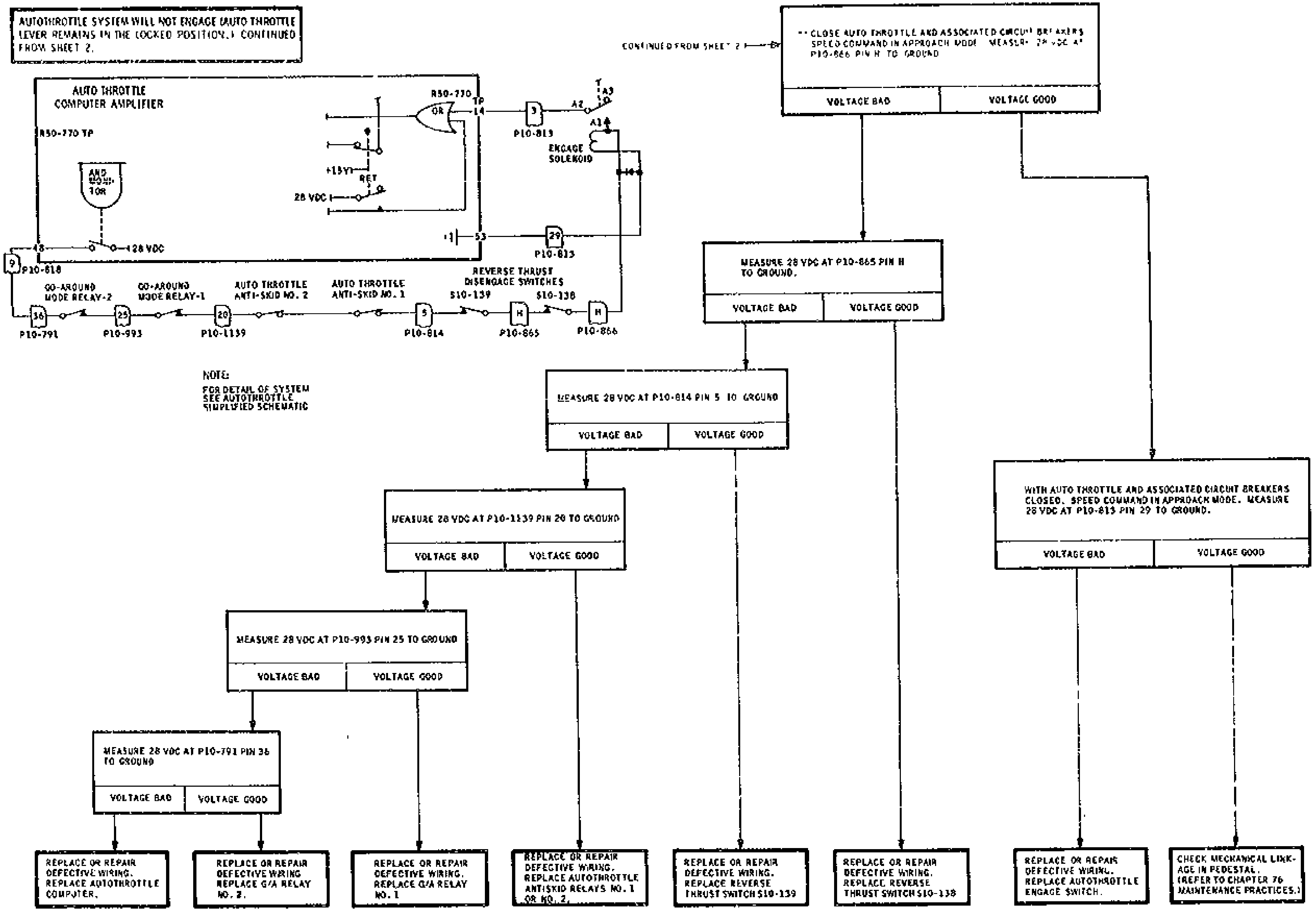




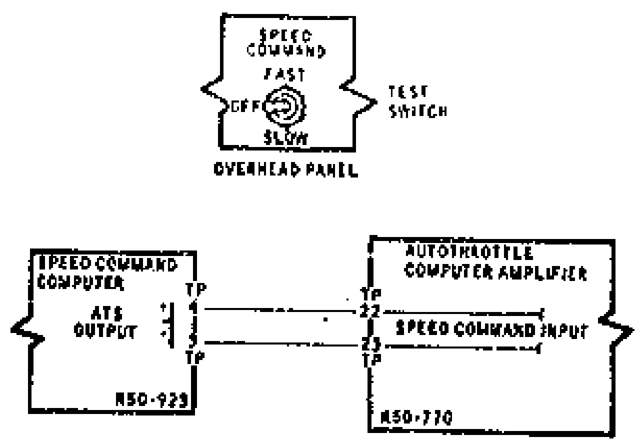
NOTE:
FOR DETAIL OF SYSTEM SEE AUTOTHROTTLE SIMPLIFIED SCHEMATIC.

HA2-6863

Autothrottle System Will Not Engage (Autothrottle Lever Remains Locked In The Disengage Position)
Figure 103 (Sheet 2)



Autothrottle System Will Not Engage (Autothrottle Lever Remains Locked In The Disengage Position)
Figure 103 (Sheet 3)



NOTE:
DETAIL OF SYSTEM IS SHOWN ON AUTOTHROTTLE SIMPLIFIED SCHEMATIC.

AUTOTHROTTLE ENGAGES PROPERLY. AUTOTHROTTLE LEVERS DO NOT FOLLOW UP TO CENTER FAST-SLOW INDICATOR.

PROBABLE FAULT
1. AUTOTHROTTLE COMPUTER.
2. AUTOTHROTTLE SERVO MOTOR.
3. SPEED COMMAND COMPUTER.
4. MAXIMUM AUTHORITY SWITCHES.
5. MINIMUM AUTHORITY SWITCHES.

CLOSE AUTOTHROTTLE, SPEED COMMAND, FLIGHT DIRECTOR, AND ASSOCIATED CIRCUIT BREAKERS. PLACE FLIGHT DIRECTOR IN ANY MODE EXCEPT G.A. OR OFF POSITION. OPEN BOTH GROUND CONTROL RELAY CIRCUIT BREAKERS. SPEED COMMAND SYSTEM IN APPROACH MODE. FAST-SLOW INDICATOR SHOULD REMAIN AWAY FROM CENTER TOWARDS THE SLOW LEGEND. WITH ALL THROTTLE LEVERS AT THEIR AFT MECHANICAL STOP, ENGAGE AUTOTHROTTLE SYSTEM. THROTTLES SHOULD MOVE FORWARD TOGETHER AT MAXIMUM RATE (APPROXIMATELY 6 DEGREES PER SECOND) TO 1.0 ± 0.27 INCHES FROM IDLE AND CONTINUE FORWARD AT THE SAME OR DECREASED RATE TO 3.8 ± 0.27 INCHES POSITION. THIS TESTS SPEED COMMAND INPUT TO THE AUTOTHROTTLE COMPUTER.

- THROTTLES DO NOT FOLLOW UP
- THROTTLES FOLLOW UP

MANUALLY MOVE ALL THROTTLE LEVERS TO APPROXIMATELY 3.4 INCHES FROM IDLE. MOVE THE SPEED COMMAND TEST SWITCH TO THE FAST POSITION AND RELEASE THE THROTTLE LEVERS. THE FAST-SLOW INDICATOR SHOULD MOVE INTO THE FAST REGION, AND THROTTLE LEVERS SHOULD MOVE AFT AND STOP AT 1.0 + 0.27 INCHES FROM IDLE.

- THROTTLES DO NOT MOVE AFT

OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM THE AIRPLANE. CLOSE SPEED COMMAND CIRCUIT BREAKERS, AND PLACE SPEED COMMAND IN APPROACH MODE. PLACE FAST-SLOW SWITCH TO THE SLOW SIDE. PLACE THE POSITIVE LEAD OF THE VOLT/OHM METER ON R50-770TP PIN 23, AND THE NEGATIVE LEAD ON R50-770TP PIN 22. MEASURE 5 ± 1 VOLT. PLACE FAST-SLOW SWITCH TO THE FAST SIDE. PLACE POSITIVE LEAD OF THE VOLT/OHM METER ON R50-770TP PIN 22, AND NEGATIVE LEAD ON R50-770TP PIN 23. MEASURE 5 ± 1 VOLT.

- VOLTAGE BAD
- VOLTAGE GOOD

REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE SPEED COMMAND COMPUTER.

OPEN AUTOTHROTTLE, SPEED COMMAND, AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. ALL THROTTLES AT THE AFT MECHANICAL STOP. CONTINUITY CHECK R50-770BP PIN 5 TO PIN 6. INDIVIDUALLY MOVE THE NUMBER 2 AND NUMBER 3 THROTTLE TO 3.8 + 0.27 INCHES FORWARD FROM THE AFT MECHANICAL STOP. CONTINUITY SHOULD BE INTERRUPTED. THIS CHECKS THE MAXIMUM AUTHORITY SWITCHES.

- CONTINUITY NOT INTERRUPTED
- CONTINUITY INTERRUPTED

MOVE THE NUMBER 1 AND 4 THROTTLE FORWARD OF THE AFT MECHANICAL STOP (AT LEAST 4 INCHES.) CONTINUITY CHECK R50-770BP PIN 12 TO PIN 13. INDIVIDUALLY MOVE THE NUMBER 1 AND NUMBER 4 THROTTLES AFT TO 1.0 ± 0.27 FROM THE AFT MECHANICAL STOP. CONTINUITY SHOULD BE INTERRUPTED. THIS CHECKS THE MINIMUM AUTHORITY SWITCHES.

- CONTINUITY NOT INTERRUPTED
- CONTINUITY INTERRUPTED

INSTALL THE AUTOTHROTTLE COMPUTER. CLOSE AUTOTHROTTLE, SPEED COMMAND, AND ASSOCIATED CIRCUIT BREAKERS. ENGAGE AUTOTHROTTLE, MEASURE 28 VDC AT P10-813 PIN 15 TO GROUND.

- VOLTAGE BAD
- VOLTAGE GOOD

CONTINUED ON SHEET 2*

REPLACE DEFECTIVE MAXIMUM AUTHORITY SWITCHES.

REPLACE DEFECTIVE MINIUM AUTHORITY SWITCHES.

REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE SERVO MOTOR.

HA2-6876

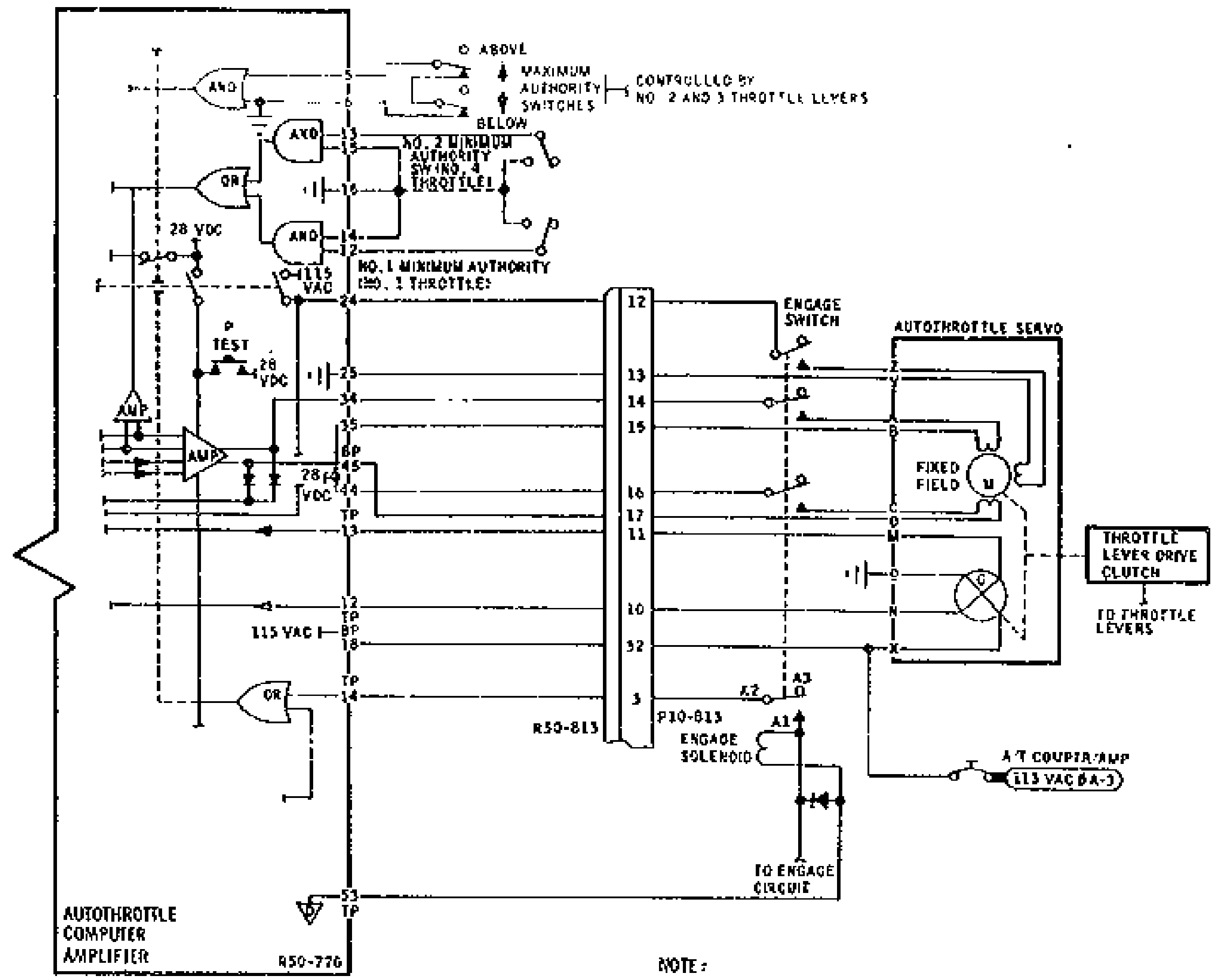
Autothrottle Engages Properly. Autothrottle Levers Do Not Follow Up To Center Fast-Slow Indicator
Figure 104 (1)

AUTOTHROTTLE ENGAGES PROPERLY. AUTOTHROTTLE LEVERS DO NOT FOLLOW UP TO CENTER FAST-SLOW INDICATOR. (CONTINUED FROM SHEET 1.)

CONTINUED FROM SHEET 1

WITH AUTOTHROTTLE ENGAGED, MEASURE 28 VDC AT P10-813 PIN 16 TO GROUND.

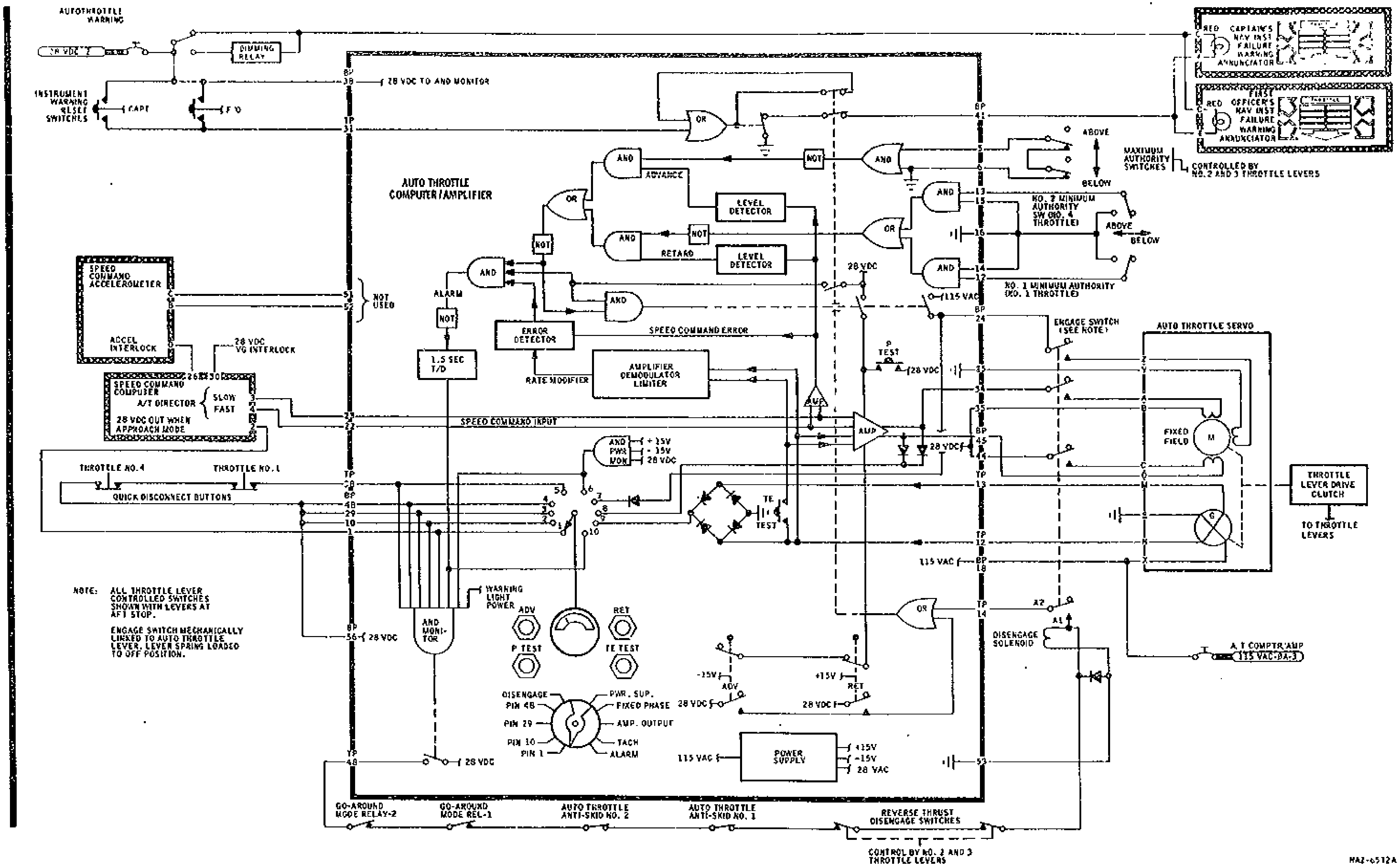
- VOLTAGE BAD: REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE SERVO MOTOR.
- VOLTAGE GOOD: WITH AUTOTHROTTLE ENGAGED, MEASURE 115 VAC AT P10-813 PIN 12 TO GROUND.
  - VOLTAGE BAD: REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE SERVO MOTOR.
  - VOLTAGE GOOD: WITH AUTOTHROTTLE ENGAGED, SPEED COMMAND IN APPROACH MODE, MEASURE 28 VDC AT P10-813 PIN 3 TO GROUND.
    - VOLTAGE BAD: REPLACE OR REPAIR DEFECTIVE WIRING. REFER TO LOGIC DIAGRAM AUTOTHROTTLE SYSTEM WILL NOT ENGAGE (AUTOTHROTTLE LEVERS REMAIN LOCKED IN THE DISENGAGE POSITION.)
    - VOLTAGE GOOD: REPLACE AUTOTHROTTLE COMPUTER.



NOTE: DETAIL OF SYSTEM IS SHOWN ON AUTOTHROTTLE SIMPLIFIED SCHEMATIC.

HA7-6677

Autothrottle Engages Properly. Autothrottle Levers Do Not Follow Up To Center Fast-Slow Indicator
Figure 104 (Sheet 2)



Autothrottle System -- Schematic
Figure 105

AUTO THROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting the auto throttle system requires proper operation of the auto throttle interlock and the vertical gyro systems. The throttles should be rigged and in working order, and the elevator trailing edge should be at neutral position, 10 (±3/16) inches below marked rivet on the left side of the tail cone.

B. Auto throttle trouble shooting is performed using the captain's controls and indicators. Tests performed at the captain's flight station are primarily system tests and do not alone determine failure of a particular component. Troubles involving throttle motions and airplane dynamics may not be detected during ground check and the area of failure may have to be determined by process of elimination.

2. Tools and Equipment Required

A. A multimeter, Simpson model 260 or equivalent, is required to perform voltage and continuity checks.

3. Trouble Shooting Procedures

Possible Causes	Isolation Procedure	Correction
A. AUTO THROTTLE SYSTEM WILL NOT ENGAGE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace auto throttle computer.
(2) Quick disconnect switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pin 10 and top plug pin 38. No continuity indicates open quick disconnect switch or wiring.	Replace quick disconnect switch or repair wiring as necessary.
(3) Disengage solenoid defective.	Check for 28 vdc at solenoid terminal X1 (throttle levers in mid-quad position).	If 28 vdc is present replace solenoid; if not remove computer. Check continuity between X1 and computer receptacle rack mounted top plug pin 48. Repair as necessary.

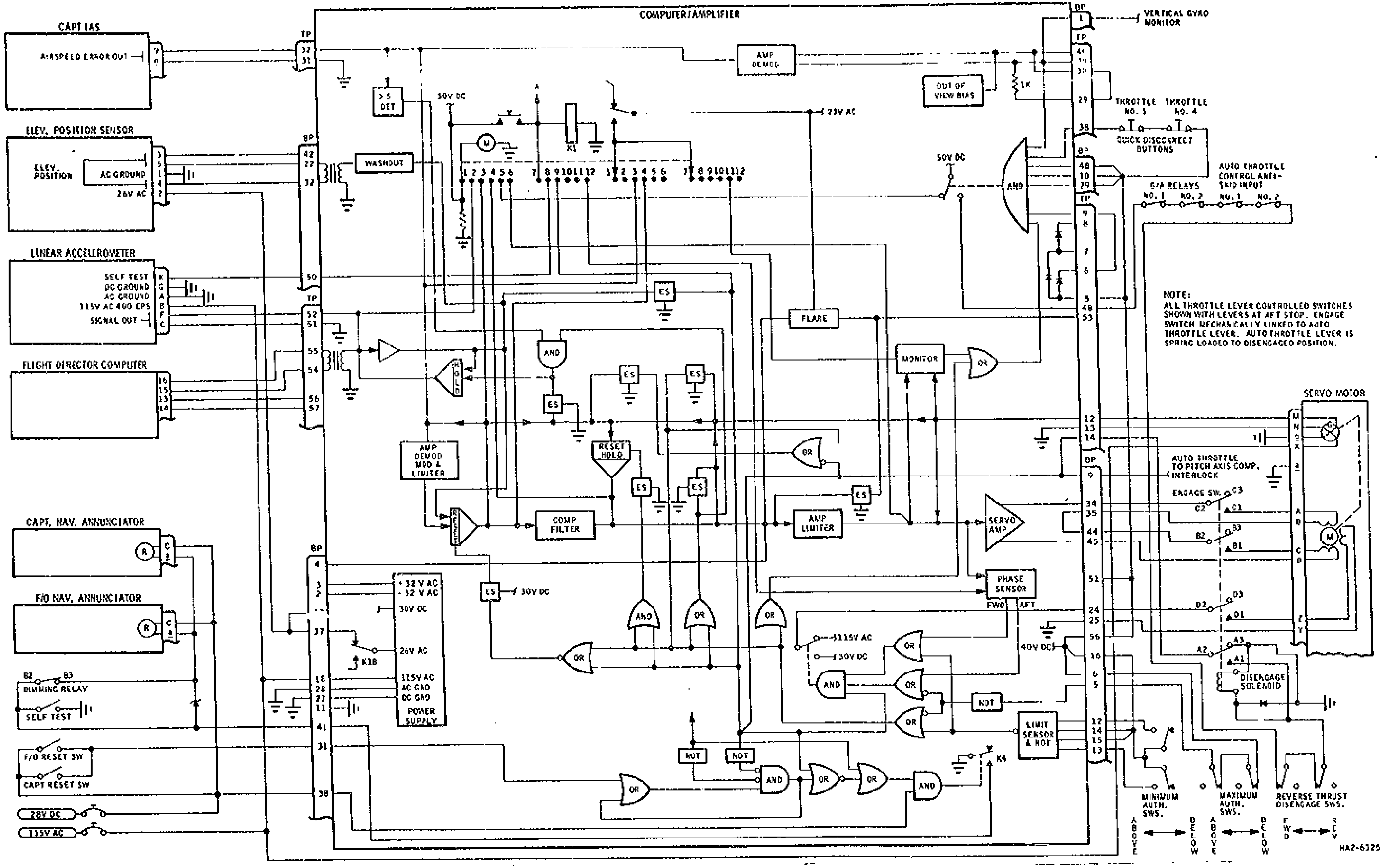
Possible Causes	Isolation Procedure	Correction
B. AUTO THROTTLE LEVER WILL NOT HOLD IN ENGAGE POSITION		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Servo motor defective.	Rotate self test selector switch to position 4. Self-test meter should indicate below yellow range within 20 seconds. Press and hold press-to test switch, meter should indicate in yellow range within 30 seconds.	Replace servo motor.
(3) Engage switch defective or wiring defective.	(1) Remove computer. Disconnect servo motor electrical connector, check continuity between rack mounted computer receptacle bottom plug pins 35, 25, and 45, and servo motor connector pins B, D, and Y respectively.	Repair wiring as necessary.
	(2) Check for no continuity between bottom plug pins 34, 44, and 24, and servo connector pins A, C, and Z.	If continuity replace engage switch.
	(3) Manually hold auto throttle lever in engage position. Repeat step (2) checking for continuity.	If no continuity replace switch or repair wiring as necessary.
C. AUTO THROTTLE OFF WARNING LIGHTS DO NOT OPERATE		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Warning light or wiring defective.	Press instrument failure monitor test switch.	If lights come on repair wiring; if not replace lights.

Possible Causes	Isolation Procedure	Correction
D. AUTO THROTTLE ENGAGES PROPERLY, THROTTLES DO NOT RESPOND		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Servo motor defective.	Perform computer self-test procedure steps (2) and (14 through 19).	Replace servo motor.
(3) Airspeed error selector switch defective.	Disconnect captain's and first officer's IAS indicator electrical connector. Remove computer. With airspeed error selector switch in captain position, check for continuity between computer rack mounted receptacle top plug pins 31 and 32 and captain's indicator connector pins 8 and 9 respectively, and no continuity between pins 31 and 32 and first officer's indicator connector pins 8 and 9 respectively. Repeat above procedure with switch at first officer's position using first officer's indicator connector.	Replace switch or repair wiring as necessary.
(4) IAS indicator defective.	Observe other indicator. Perform step (3).	Replace indicator or repair wiring as necessary.
E. THROTTLE LEVERS MOVE IN WRONG DIRECTION		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Airspeed error selector switch defective.	Perform step D.(3).	
(3) IAS indicator defective.	Perform step D.(4).	

Possible Causes	Isolation Procedure	Correction
E. THROTTLE LEVERS MOVE IN WRONG DIRECTION (Continued)		
(4) Engage switch or wiring defective.	Perform step B.(3).	
F. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary (see Chapter 76).
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
G. AUTO THROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
H. THROTTLE LEVERS DO NOT STOP AT UPPER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Maximum authority switch defective.	Remove computer. Check for continuity between rack mounted computer receptacle bottom plug pins 5 and 6. Slowly advance throttles. Continuity should break at 3 13/16 (±29/64) inches forward of aft stop.	Replace or adjust switch as necessary.

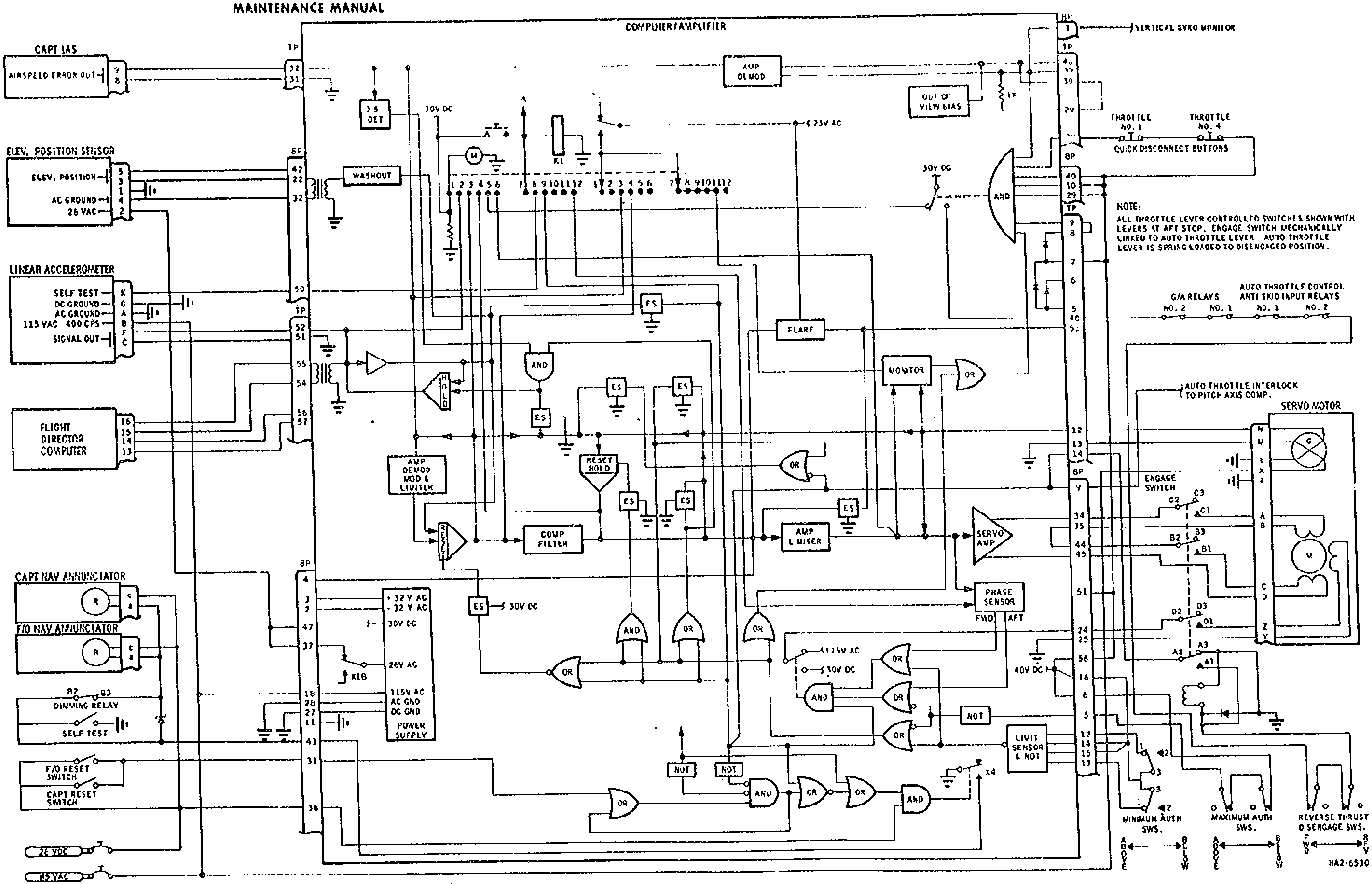
Possible Causes	Isolation Procedure	Correction
I. THROTTLE LEVERS DO NOT STOP AT LOWER LIMIT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Minimum authority switch defective.	Remove computer. Check continuity between rack mounted receptacle bottom plug pins 16 and 12, (pins 14, 15, and 16 are common). While checking continuity slowly retard throttles. Continuity should break at 1 (±1/16) inch forward of aft stop. Repeat procedure using pins 16 and 13.	Replace or adjust switch as necessary.
J. FAST/SLOW INDICATOR DOES NOT FUNCTION PROPERLY		
(1) Auto throttle computer defective.	Perform computer self-test procedure (see 22-30-0).	Replace computer.
(2) Fast/slow pointer bias relay defective.	Check for 28 vdc at relay terminal X1.	If 28 vdc is present, replace relay.
(3) Attitude director indicator defective.	Observe other indicator.	Replace defective indicator.
(4) IAS indicator defective.	See isolation procedure D.(3).	
K. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

Possible Causes	Isolation Procedure	Correction
K. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT (Continued)		
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle bottom plug pins 22, 32, and 42, and position sensor connector pins 5, 4, and 3 respectively.	Replace sensor or repair wiring as necessary.



Auto Throttle System -- Schematic
(Airplanes N8960T-N8962T)
Figure 101 (Sheet 1)

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Auto Throttle System -- Schematic
(Airplanes N4863T and Subsequent)
Figure 101 (Sheet 2)

AUTOTHROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting procedures consist primarily of isolation of faulty components. In the case of autothrottle electronic components, this can sometimes be accomplished by self-test.

B. A thorough knowledge of the interrelationship of components is essential for meaningful trouble shooting. For this reason, an autothrottle and associated system interface simplified schematic is contained in this section.

C. A Trouble Shooting Index is provided in paragraph 3. This is to be utilized as an aid to isolate particular problem areas. When a problem arises, isolate the problem area, then use the referenced logic diagram to isolate the faulty component, or defective wiring.

D. Refer to paragraph 4 for location of circuit breakers that have a direct bearing on the operation of the autothrottle and associated systems.

E. Standard electrical voltages are given in the following procedures, however it is to be understood that a 10% tolerance is permissible unless otherwise stated.

2. Tools and Equipment Required

A. The following equipment or suitable substitute may be required during trouble shooting procedures:

Item	Name	Number	Manufacturer	Use
A	Volt-Ohm Meter	Model 260	Simpson	Used to read ac and dc voltages, and to check circuit continuity, and to measure resistance.

3. Trouble Shooting Index - Autothrottle System

A. The following table lists the malfunctions that are covered in this trouble shooting procedure:

	Malfunction	Figure No.
(1)	Autothrottle Off Warning Lights Remain On	103
(2)	Autothrottle Off Warning Lights Do Not Come On	104
(3)	Autothrottle System Will Not Engage	105
(4)	Throttle Levers Drive Beyond Electrical Stops	106

4. Circuit Breakers

A. Open the following circuit breakers:

CIRCUIT BREAKER	LOCATION
ALL FUEL BOOST PUMP	AC BUSSES 1, 2, 3, & 4
ENGINE STARTERS	BATTERY BUS
IGNITION PWR SUPPLY	BATTERY BUS
IGNITION PWR SUPPLY CONT	BATTERY BUS

B. Close the following circuit breakers:

CIRCUIT BREAKER	LOCATION
AUTOTHROTTLE 115 VAC	RADIO BUS 2
AUTOTHROTTLE OFF WARN LT	RADIO BUS 3
ANTI-SKID SYSTEM	DC BUSSES 1 & 4
GROUND SPOILER CONTROL	AC BUS 4
CAPTAIN'S HORIZON	RT AC EMER BUS
GO AROUND 1 & 2	RADIO BUSSES 2 & 3

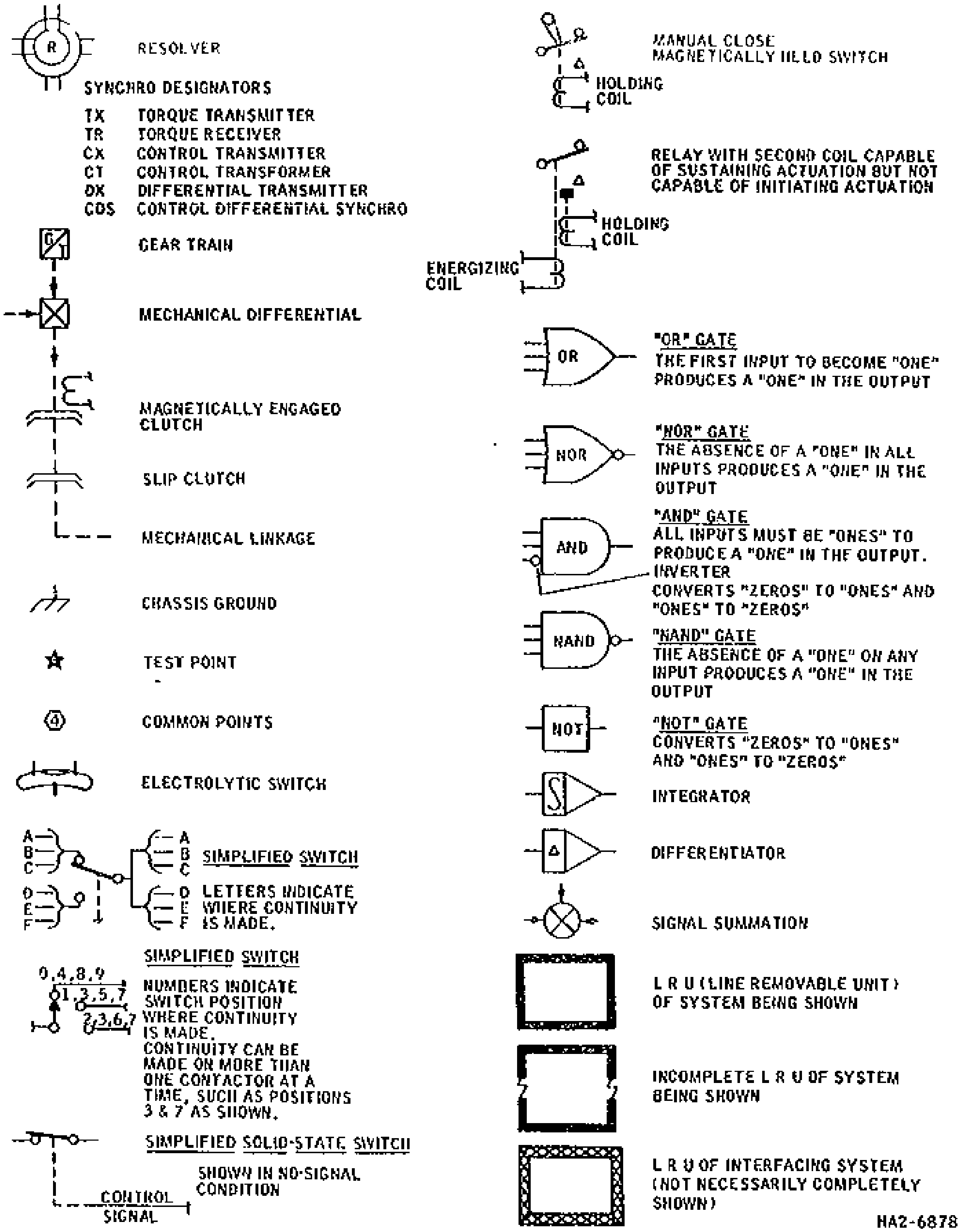
CIRCUIT BREAKER	LOCATION
RADIO BUS 2 LOAD MONITOR	RADIO BUS 2
RADIO BUS 3 LOAD MONITOR	RADIO BUS 3

5. Additional Throttle Response Problems

Possible Causes	Isolation Procedure	Correction
A. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle P10-770 bottom plug pins 22 & 32, and position sensor connector pins 5 & 4, respectively.	Replace sensor or repair wiring as necessary.
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary.

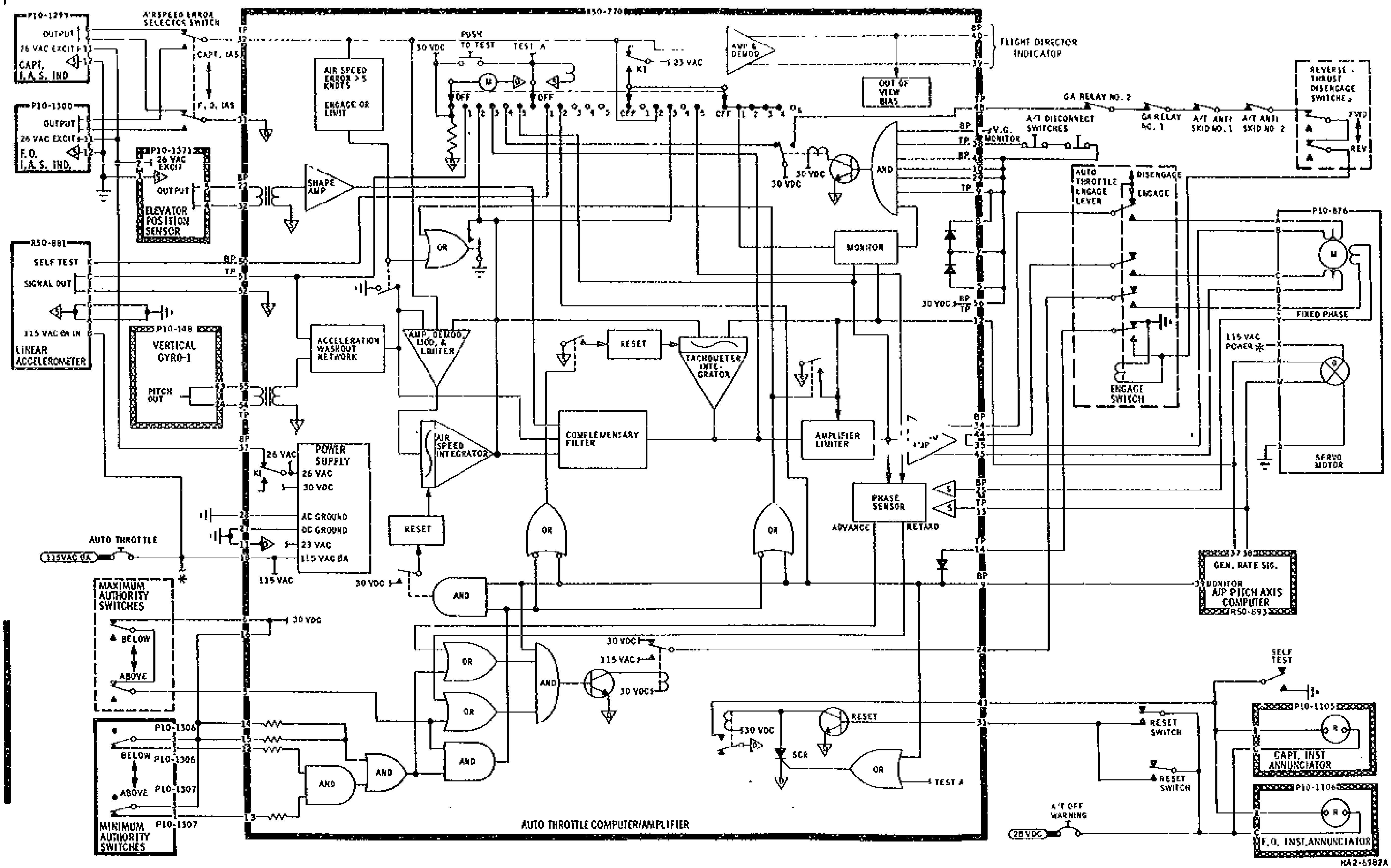
Possible Causes	Isolation Procedure	Correction
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE) (Continued)		
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
C. AUTOTHROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

SCHEMATIC SYMBOLS NOT COVERED BY ATA 100



Schematic Symbols
Figure 101

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Autothrottle System -- Schematic
Figure 102

AUTOTHROTTLE OFF WARNING LIGHTS REMAIN ON

PROBABLE FAULT

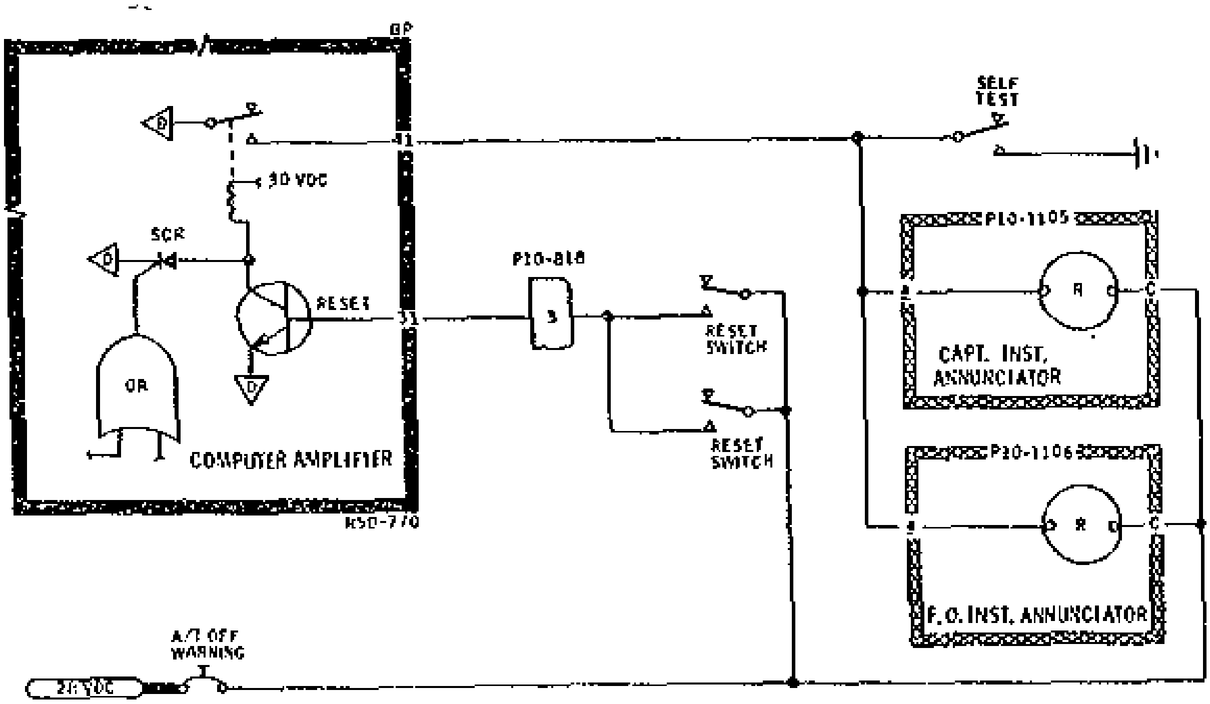
1. AUTOTHROTTLE COMPUTER.
2. AUTOTHROTTLE RESET SWITCHES.
3. DEFECTIVE WIRING.

PRESS AND RELEASE AUTOTHROTTLE RESET SWITCHES.

- LIGHT REMAINS ON

WITH AUTOTHROTTLE RELEASE SWITCHES OPEN, MEASURE 0 VDC AT P10-818 PIN 3 TO GROUND.

- VOLTAGE: REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE RESET SWITCHES.
- 0 VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKER. LIGHT SHOULD BE OUT
  - LIGHT REMAINS ON: REPLACE OR REPAIR DEFECTIVE WIRING. (R50-770 PIN 41 THROUGH FAILURE WARNING ANNUNCIATORS). CHECK FOR SHORT CIRCUITS TO GROUND.
  - LIGHT GOES OUT: REPLACE AUTOTHROTTLE COMPUTER.



HA2-7216

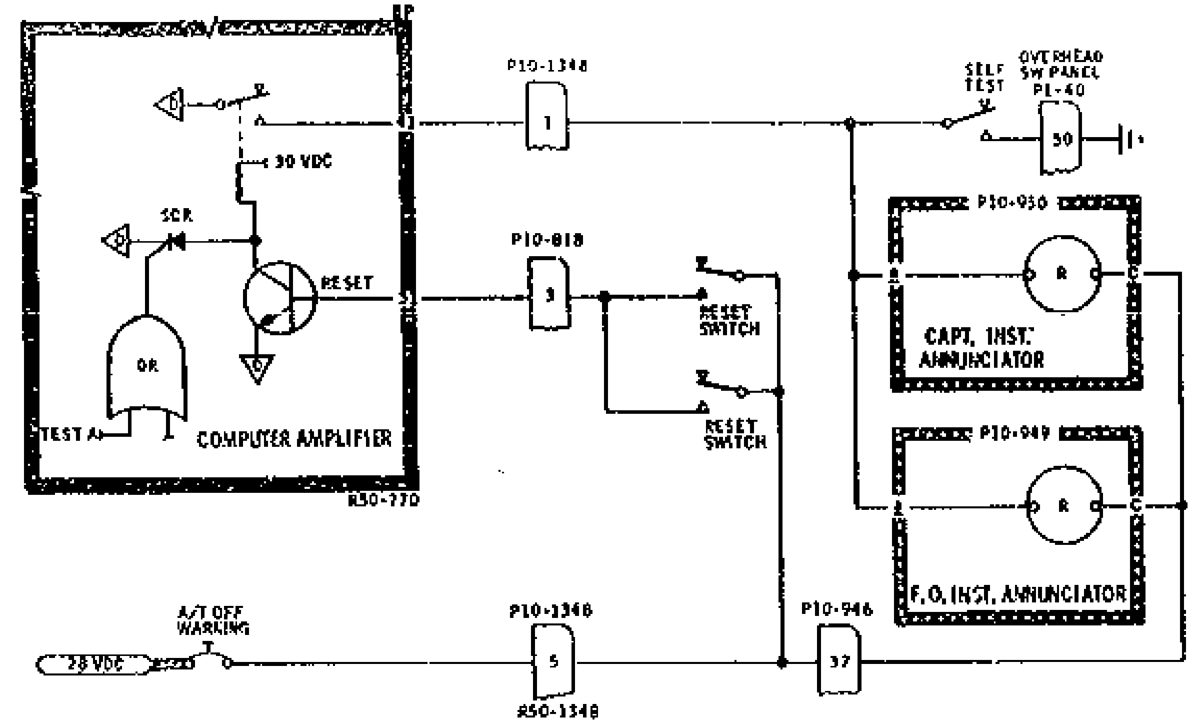
Autothrottle Off Warning Lights Remain On
Figure 103

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AUTOTHROTTLE OFF WARNING LIGHTS DO NOT LIGHT

PROBABLE FAULT

1. DEFECTIVE ANNUNCIATOR BULB
2. AUTOTHROTTLE COMPUTER.
3. AUTOTHROTTLE RESET SWITCHES.
4. SELF TEST SWITCH.
5. NAV INSTRUMENT FAILURE WARNING ANNUNCIATOR.



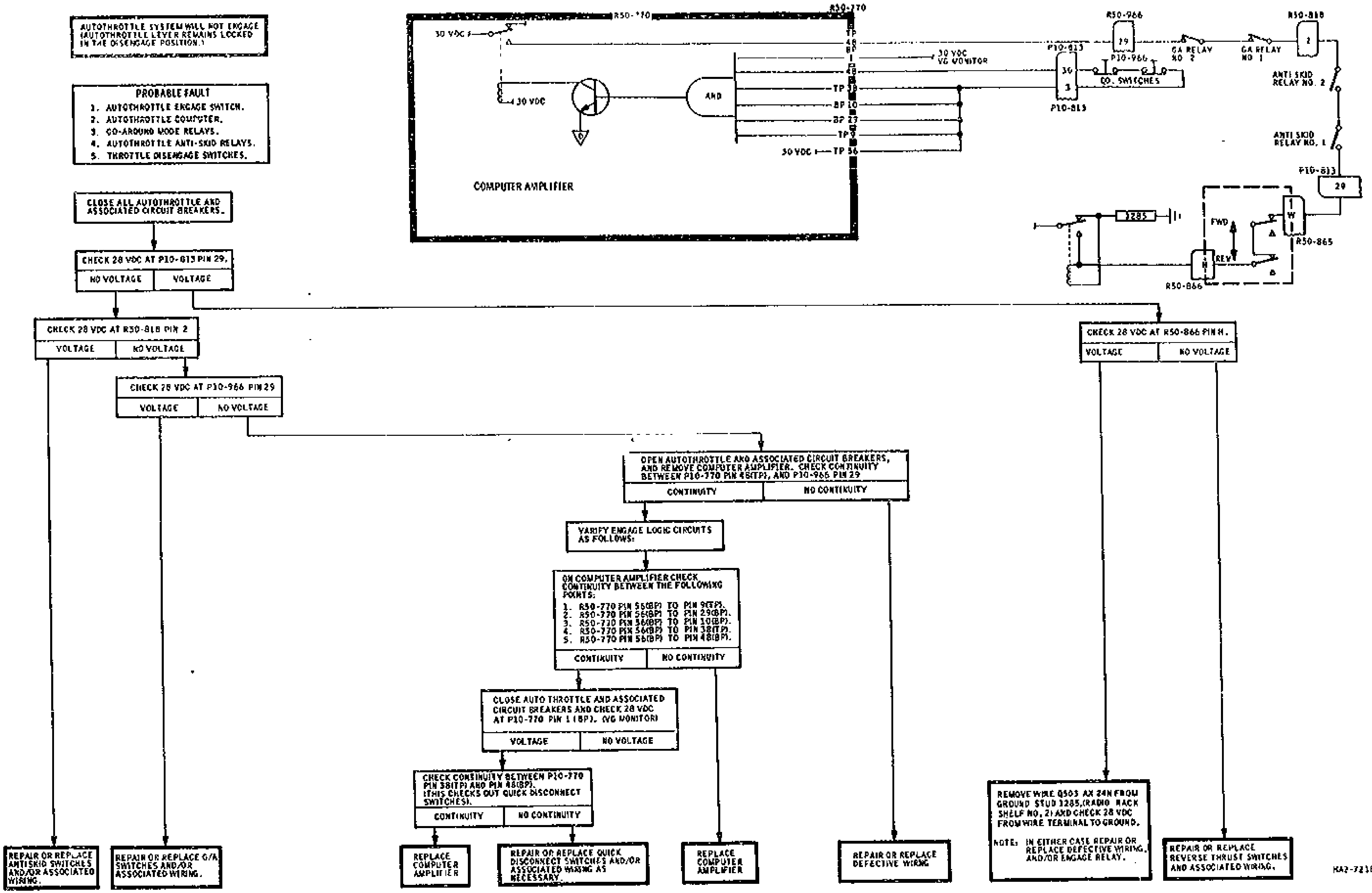
WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PLACE NAV/INST ANNUNCIATOR DIMMING UNIT TO THE BRIGHT POSITION. PRESS SELF TEST SWITCH ON OVERHEAD SWITCH PANEL. AUTOTHROTTLE ANNUNCIATOR SHOULD COME ON.

- LIGHT DOES NOT COME ON IN SELF TEST.
  - REPLACE AUTOTHROTTLE ANNUNCIATOR BULB AND PERFORM ABOVE SELF TEST.
    - LIGHT STILL DOES NOT COME ON.
      - CHECK CONTINUITY FROM P1-40 PIN 30 TO GROUND.
        - NO CONTINUITY: REPLACE OR REPAIR DEFECTIVE WIRING CHECK GROUND FOR LOOSE OR DIRTY CONNECTION.
        - CONTINUITY: CHECK FOR 28 VDC AT P10-1348 PIN 5.
          - NO VOLTAGE: REPLACE CIRCUIT BREAKER
          - VOLTAGE: CHECK FOR 28 VDC AT P10-946 PIN 37
            - NO VOLTAGE: REPAIR OR REPLACE DEFECTIVE WIRING.
            - VOLTAGE: DEPRESS AND HOLD SELF TEST SWITCH. MEASURE 28 VDC AT P1-40 PIN 30.
              - NO VOLTAGE: REPLACE SELF TEST SWITCH.
              - VOLTAGE: TROUBLE SHOOT ANNUNCIATORS. REPAIR OR REPLACE AS NECESSARY.
- LIGHT COMES ON IN SELF TEST ONLY.
  - WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PRESS AND RELEASE INSTRUMENT WARNING RESET SWITCHES. MEASURE ZERO VDC AT P10-818 PIN 3 TO GROUND.
    - VOLTAGE: REPLACE OR REPAIR DEFECTIVE WIRING AND/OR RESET SWITCHES.
    - ZERO VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKERS. JUMPER R50-770BP PIN 41 TO GROUND.
      - LIGHT COMES ON: REPLACE AUTOTHROTTLE COMPUTER.
      - LIGHT DOES NOT COME ON: REPLACE OR REPAIR DEFECTIVE WIRING.

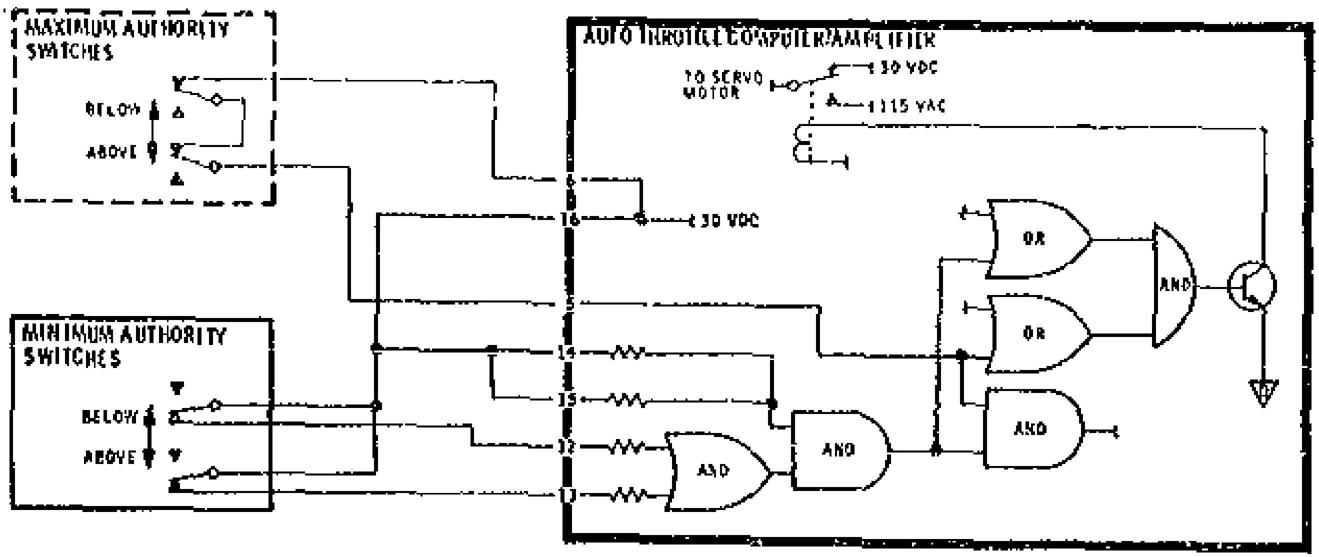
NOTE:
IF SYSTEM CHECKS OUT AND LIGHT STILL DOES NOT COME ON, NAV. INST. DIMMER SWITCH SHOULD BE CHECKED.

HA2-7217

Autothrottle Off Warning Lights Do Not Come On
Figure 104



Autothrottle System Will Not Engage
Figure 105



WITH AUTO THROTTLE ENGAGED, THROTTLE LEVERS DRIVE BEYOND ELECTRICAL STOPS.

PROBABLE CAUSES:

MINIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

MAXIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

IN WHICH DIRECTION DO THROTTLES DRIVE BEYOND LIMITS?

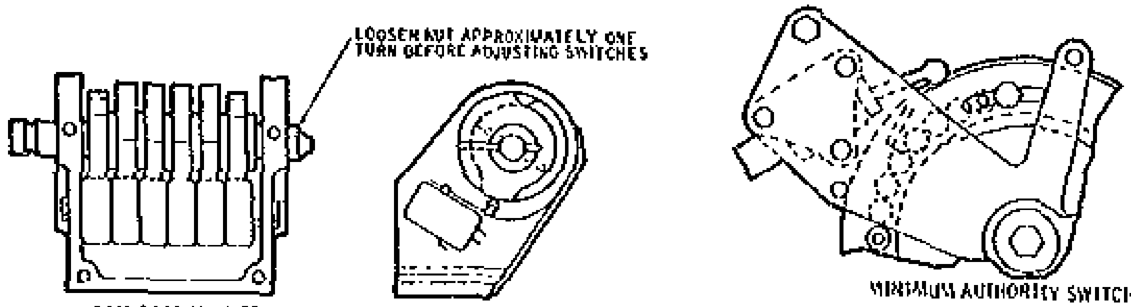
MAXIMUM	MINIMUM

MAXIMUM:

1. POSITION NUMBER 2 AND NUMBER 3 THROTTLE LEVER 3 13/16 ± 1/16 INCHES FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLER MOVES FROM LOW TO HIGH PORTION OF CAM.
3. TORQUE CAM SHAFT RETAINING NUT TO 60 INCH POUNDS AND SECURE WITH COTTER KEY.
4. VERIFY THAT SWITCHES DEACTUATE AT 3 13/16 INCHES FORWARD OF AFT STOP WHILE THROTTLES ARE MOVING IN POWER ON DIRECTION.

MINIMUM:

1. POSITION NUMBER 1 AND NUMBER 4 THROTTLE LEVER 1 INCH FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLERS MOVE FROM HIGH TO LOW PORTION OF CAM.
3. VERIFY THAT SWITCHES DEACTUATE 1 ± 1/16 INCHES FROM AFT STOP WHILE THROTTLE LEVERS ARE MOVING IN POWER OFF DIRECTION.



CAM ASSEMBLY-PEDESTAL THROTTLE SWITCHES

MINIMUM AUTHORITY SWITCH

HA2-7070

Throttle Levers Drive Beyond Limits
Figure 106

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AUTOTHROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting procedures consist primarily of isolation of faulty components. In the case of autothrottle electronic components, this can sometimes be accomplished by self-test.

B. A through knowledge of the interrelationship of components is essential for meaningful trouble shooting. For this reason, an autothrottle and associated system interface simplified schematic is contained in this section.

C. A Trouble Shooting Index is provided in paragraph 3. This is to be utilized as an aid to isolate particular problem areas. When a problem arises, isolate the problem area, then use the referenced logic diagram to isolate the faulty component, or defective wiring.

D. Refer to paragraph 4 for location of circuit breakers that have a direct bearing on the operation of the autothrottle and associated systems.

E. Standard electrical voltages are given in the following procedures, however it is to be understood that a 10% tolerance is permissible unless otherwise stated.

2. Tools and Equipment Required

A. The following equipment or suitable substitute may be required during trouble shooting procedures:

Item	Name	Number	Manufacturer	Use
A	Volt-Ohm Meter	Model 260	Simpson	Used to read ac and dc voltages, and to check circuit continuity, and to measure resistance.

3. Trouble Shooting Index - Autothrottle System

A. The following table lists the malfunctions that are covered in this trouble shooting procedure:

	Malfunction	Figure No.
(1)	Autothrottle Off Warning Lights Remain On	103
(2)	Autothrottle Off Warning Lights Do Not Come On	104
(3)	Autothrottle System Will Not Engage	105
(4)	Throttle Levers Drive Beyond Electrical Stops	106

4. Circuit Breakers

A. Open the following circuit breakers:

CIRCUIT BREAKER	LOCATION
ALL FUEL BOOST PUMP	AC BUSSES 1, 2, 3, & 4
ENGINE STARTERS	BATTERY BUS
IGNITION PWR SUPPLY	BATTERY BUS
IGNITION PWR SUPPLY CONT	BATTERY BUS

B. Close the following circuit breakers:

CIRCUIT BREAKER	LOCATION
AUTOTHROTTLE 115 VAC	RADIO BUS 3
AUTOTHROTTLE OFF WARN LT	RADIO BUS 2
ANTI-SKID SYSTEM	DC BUSSES 1 & 4
GROUND SPOILER CONTROL	AC BUS 4
COPILOT'S HORIZON	RT AC EMER BUS

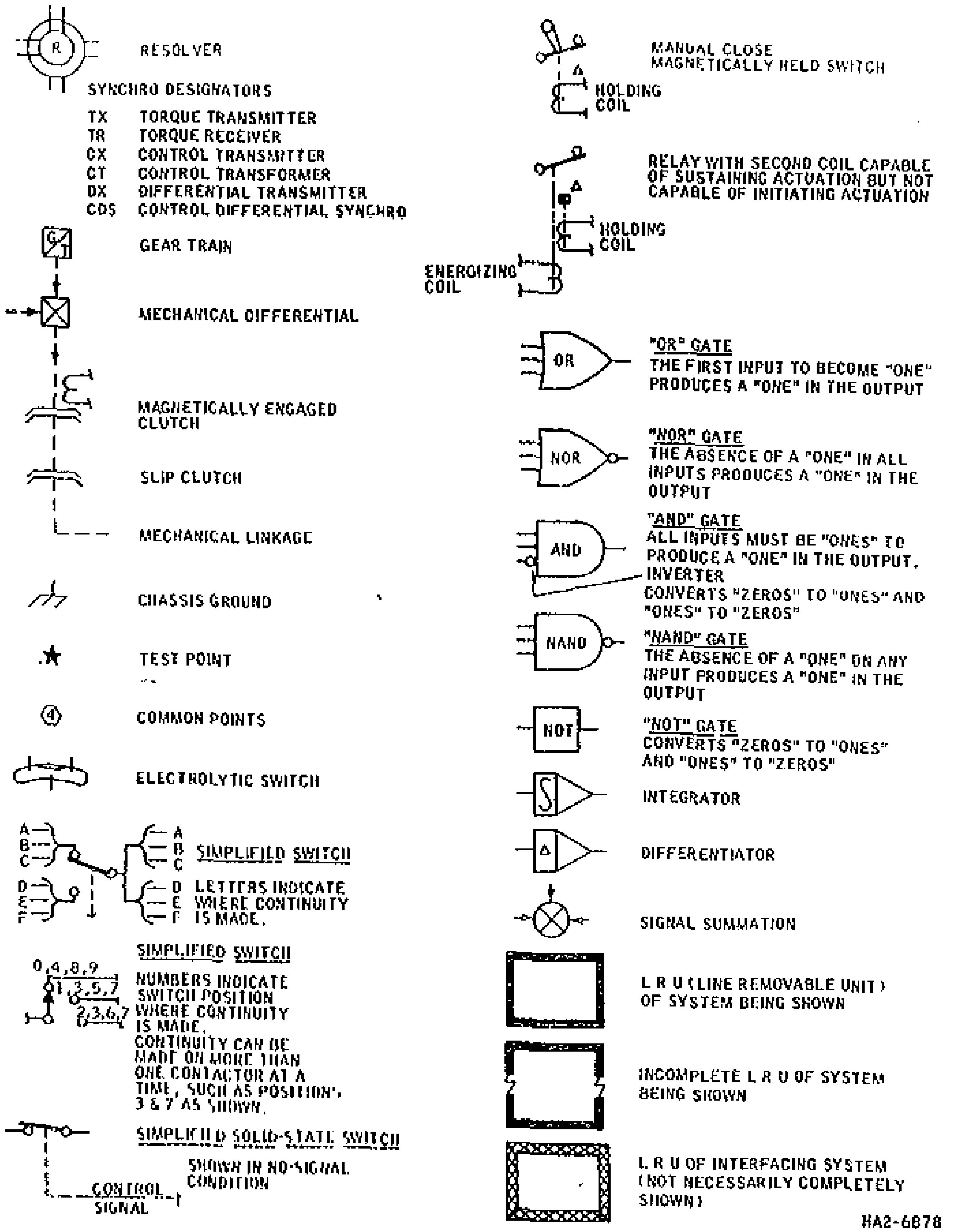
CIRCUIT BREAKER	LOCATION
GO AROUND 1 & 2	RADIO BUSSES 2 & 3
RADIO BUS 2 LOAD MONITOR	RADIO BUS 2
RADIO BUS 3 LOAD MONITOR	RADIO BUS 3

5. Additional Throttle Response Problems

Possible Causes	Isolation Procedure	Correction
A. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle P10-770 bottom plug pins 22 & 32, and position sensor connector pins 5 & 4, respectively.	Replace sensor or repair wiring as necessary.
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0. Maintenance Practices.	Adjust linkage as necessary.

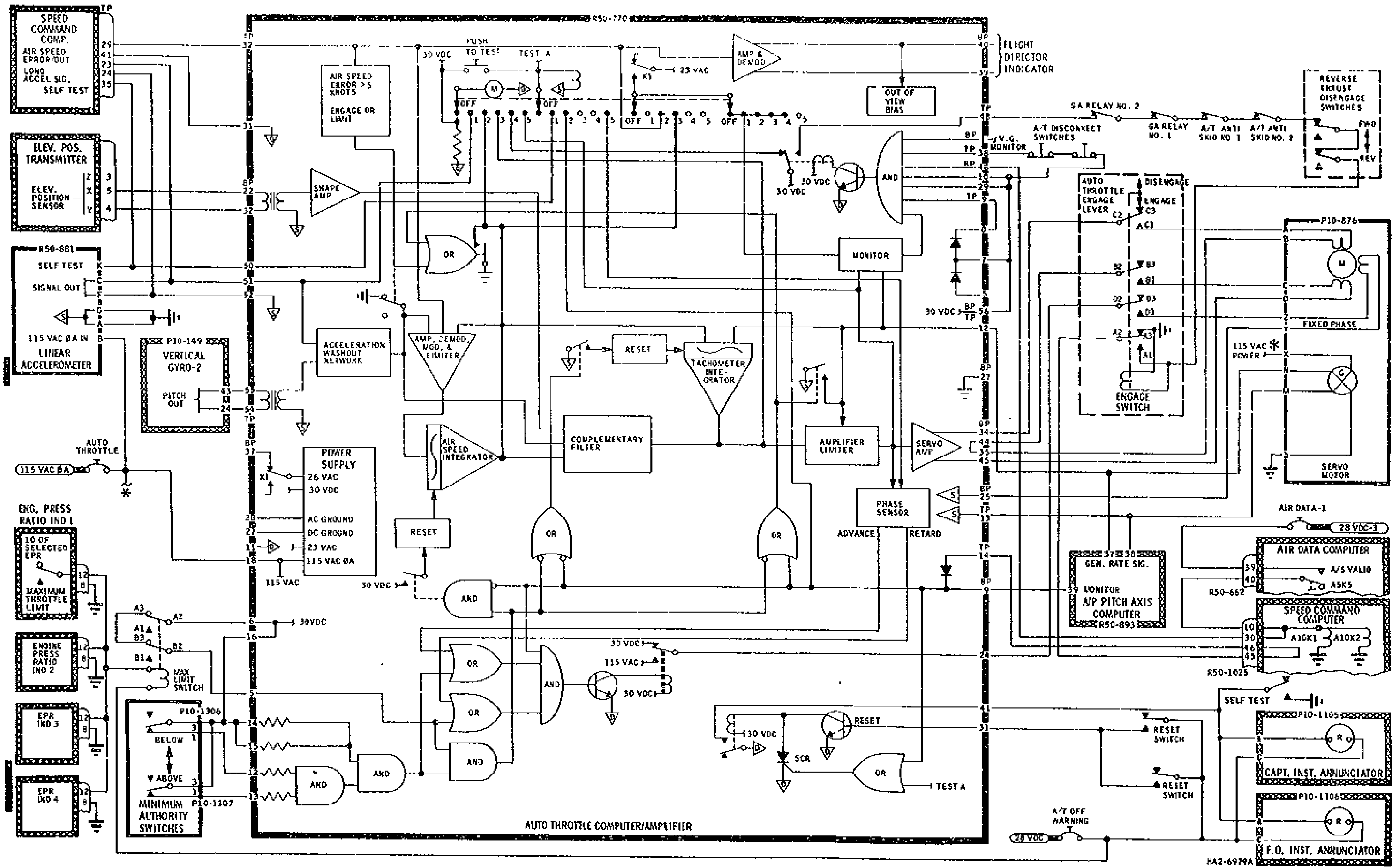
Possible Causes	Isolation Procedure	Correction
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE) (Continued)		
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
C. AUTOTHROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

SCHEMATIC SYMBOLS NOT COVERED BY ATA 100



Schematic Symbols
Figure 101

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Autothrottle System -- Schematic
Figure 102

AUTOTHROTTLE OFF WARNING LIGHTS REMAIN ON

PROBABLE FAULT

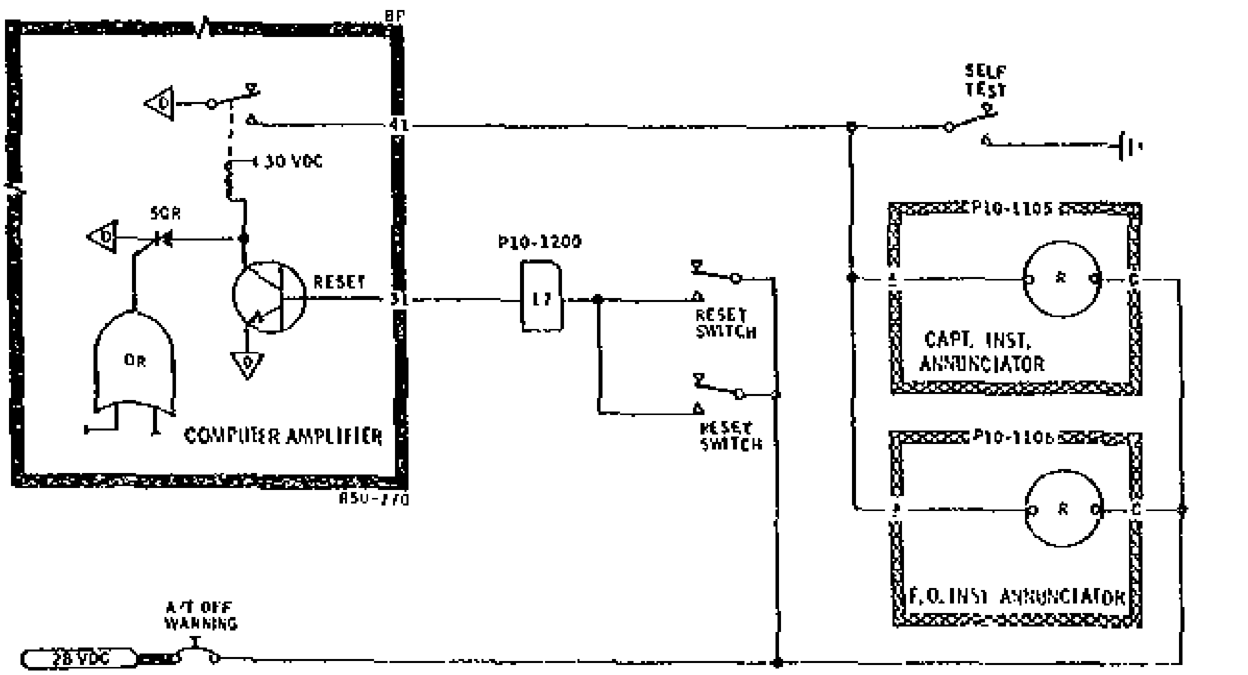
1. AUTOTHROTTLE COMPUTER.
2. AUTOTHROTTLE RESET SWITCHES.
3. DEFECTIVE WIRING.

PRESS AND RELEASE AUTOTHROTTLE RESET SWITCHES.

- LIGHT REMAINS ON →

WITH AUTOTHROTTLE RELEASE SWITCHES OPEN, MEASURE 0 VDC AT P10-1200 PIN 17 TO GROUND

- VOLTAGE → REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE RESET SWITCHES.
- 0 VOLTAGE → OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKER. LIGHT SHOULD BE OUT.
  - LIGHT REMAINS ON → REPLACE OR REPAIR DEFECTIVE WIRING. (A50-770 PIN 41 THROUGH FAILURE WARNING ANNUNCIATORS). CHECK FOR SHORT CIRCUITS TO GROUND.
  - LIGHT GOES OUT → REPLACE AUTOTHROTTLE COMPUTER.



HA2-7354

Autothrottle Off Warning Lights Remain On
Figure 103

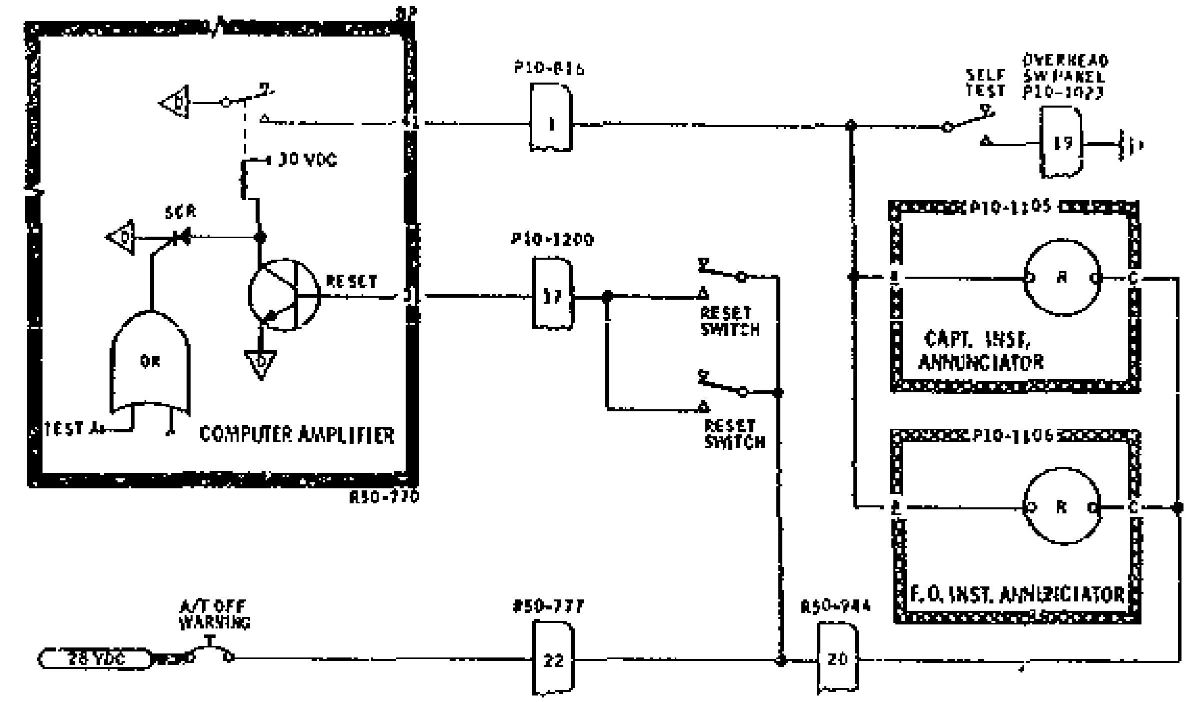
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AUTOTHROTTLE OFF WARNING LIGHTS DO NOT LIGHT

PROBABLE FAULT

1. DEFECTIVE ANNUNCIATOR BULB
2. AUTOTHROTTLE COMPUTER.
3. AUTOTHROTTLE RESET SWITCHES
4. SELF TEST SWITCH.
5. NAV INSTRUMENT FAILURE WARNING ANNUNCIATOR.



WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED. PLACE NAV/INST ANNUNCIATOR DIMMING UNIT TO THE BRIGHT POSITION. PRESS SELF TEST SWITCH ON OVERHEAD SWITCH PANEL. AUTOTHROTTLE ANNUNCIATOR SHOULD COME ON.

- **LIGHT DOES NOT COME ON IN SELF TEST.**
  - REPLACE AUTOTHROTTLE ANNUNCIATOR BULB AND PERFORM ABOVE SELF TEST.
    - **LIGHT STILL DOES NOT COME ON.**
      - CHECK CONTINUITY FROM P10-1023 PIN 19 TO GROUND.
        - **NO CONTINUITY** → REPLACE OR REPAIR DEFECTIVE WIRING CHECK GROUND FOR LOOSE OR DIRTY CONNECTION.
        - **CONTINUITY** → CHECK FOR 28 VDC AT R50-777 PIN 22
          - **NO VOLTAGE** → REPLACE CIRCUIT BREAKER
          - **VOLTAGE** → CHECK FOR 28 VDC AT R50-944 PIN 20
            - **NO VOLTAGE** → REPAIR OR REPLACE DEFECTIVE WIRING.
            - **VOLTAGE** → DEPRESS AND HOLD SELF TEST SWITCH MEASURE 28 VDC AT P10-1023 PIN 19
              - **NO VOLTAGE** → REPLACE SELF TEST SWITCH.
              - **VOLTAGE** → TROUBLE SHOOT ANNUNCIATORS. REPAIR OR REPLACE AS NECESSARY.
- **LIGHT COMES ON IN SELF TEST ONLY.**
  - WITH AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS CLOSED PRESS AND RELEASE INSTRUMENT WARNING RESET SWITCHES. MEASURE ZERO VDC AT P10-1200 PIN 17 TO GROUND.
    - **VOLTAGE** → REPLACE OR REPAIR DEFECTIVE WIRING AND/OR RESET SWITCHES.
    - **ZERO VOLTAGE** → OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKERS. JUMPER R50-770BP PIN 41 TO GROUND.
      - **LIGHT COMES ON** → REPLACE AUTOTHROTTLE COMPUTER.
      - **LIGHT DOES NOT COME ON** → REPLACE OR REPAIR DEFECTIVE WIRING.

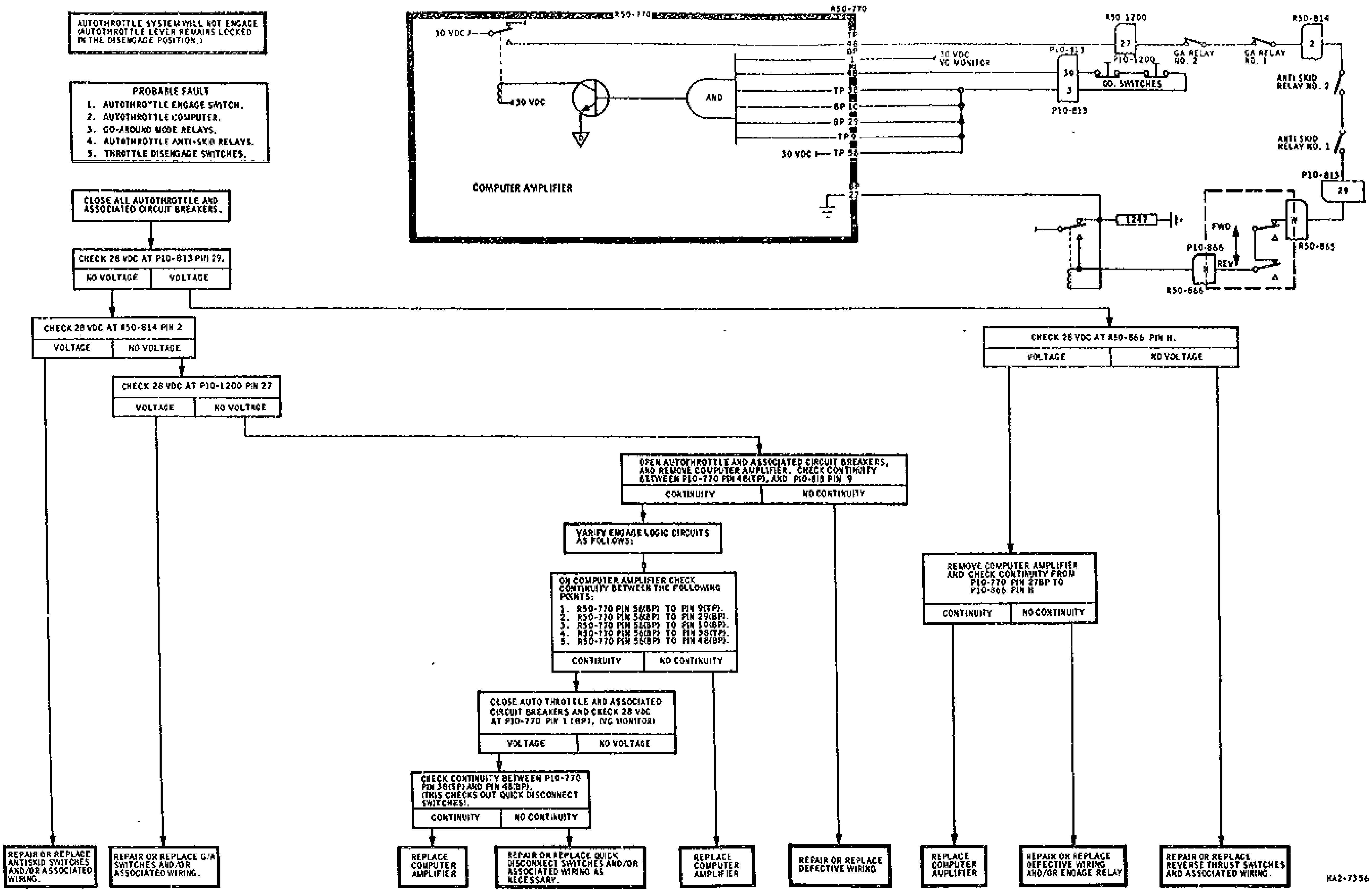
NOTE:

IF SYSTEM CHECKS OUT AND LIGHT STILL DOES NOT COME ON, NAV. INST. DIMMER SWITCH SHOULD BE CHECKED.

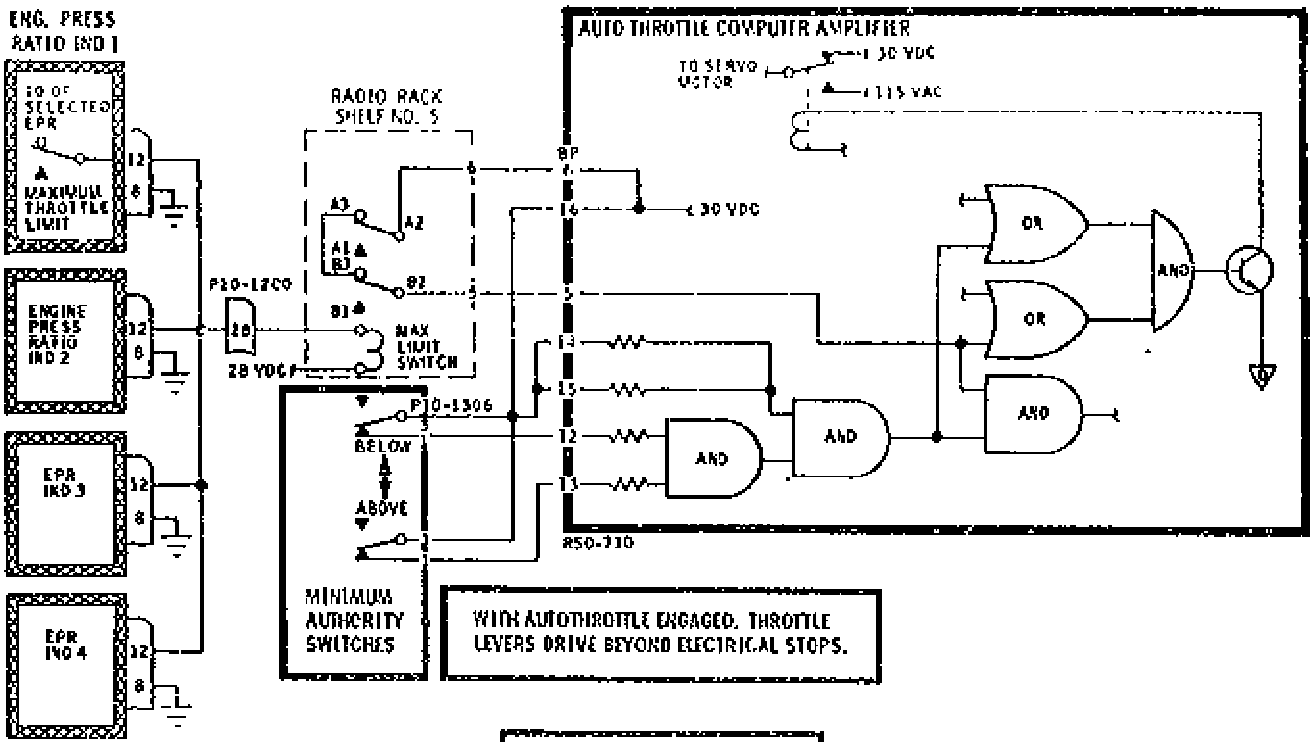
BA2-7355

Autothrottle Off Warning Lights Do Not Come On
Figure 104

Printed in U.S.A.



Autothrottle System Will Not Engage
Figure 105



PROBABLE CAUSES:

MINIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

DEFECTIVE SIGNALS FROM ENGINE PRESSURE RATIO INDICATORS.

IN WHICH DIRECTION DO THROTTLES DRIVE BEYOND LIMITS?

MAXIMUM	MINIMUM

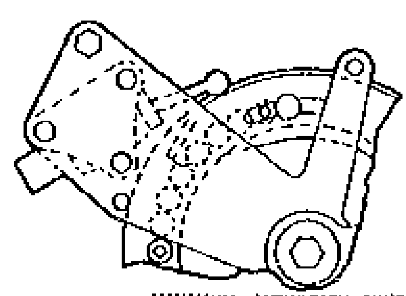
MAXIMUM:

AT P10-1200 PIN 28 CHECK FOR 28 VDC.

VOLTAGE	NO VOLTAGE
MALFUNCTION PROBABLY IN ONE OF EPR INDICATORS REFER TO 77-13-0 FOR EPR CHECK-OUT	REPAIR OR REPLACE DEFECTIVE WIRING AND/OR CIRCUIT BREAKERS.

MINIMUM:

1. POSITION NUMBER 1 AND NUMBER 4 THROTTLE LEVER 1 INCH FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLERS MOVE FROM HIGH TO LOW PORTION OF CAM.
3. VERIFY THAT SWITCHES DEACTUATE 1 ±1/16 INCHES FROM AFT STOP WHILE THROTTLE LEVERS ARE MOVING IN POWER OFF DIRECTION.



MINIMUM AUTHORITY SWITCHES

HA2-7357

Throttle Levers Drive Beyond Limits
Figure 106

AUTOTHROTTLE - TROUBLE SHOOTING

1. General

   A. Trouble shooting procedures consist primarily of isolation of faulty components. In the case of autothrottle electronic components, this can sometimes be accomplished by self-test.

   B. A thorough knowledge of the interrelationship of components is essential for meaningful trouble shooting. For this reason, an autothrottle and associated system interface simplified schematic is contained in this section.

   C. A Trouble Shooting Index is provided in paragraph 3. This is to be utilized as an aid to isolate particular problem areas. When a problem arises, isolate the problem area, then use the referenced logic diagram to isolate the faulty component, or defective wiring.

   D. Refer to paragraph 4 for location of circuit breakers that have a direct bearing on the operation of the autothrottle and associated systems.

   E. Standard electrical voltages are given in the following procedures, however it is to be understood that a 10% tolerance is permissible unless otherwise stated.

2. Tools and Equipment Required

   A. The following equipment or suitable substitute may be required during trouble shooting procedures:

Item	Name	Number	Manufacturer	Use
A	Volt-Ohm Meter	Model 260	Simpson	Used to read ac and dc voltages, and to check circuit continuity, and to measure resistance.

3. Trouble Shooting Index - Autothrottle System

A. The following table lists the malfunctions that are covered in this trouble shooting procedure:

	Malfunction	Figure No.
(1)	Autothrottle Off Warning Lights Remain On.	103
(2)	Autothrottle Off Warning Lights Do Not Come On.	104
(3)	Autothrottle System Will Not Engage.	105
(4)	Throttle Levers Drive Beyond Electrical Stops.	106

4. Circuit Breakers

A. Open the following circuit breakers:

CIRCUIT BREAKER	LOCATION
All FUEL BOOST PUMP	AC BUSSES 1, 2, 3, & 4
ENGINE STARTERS	BATTERY BUS
IGNITION PWR SUPPLY	BATTERY BUS
IGNITION PWR SUPPLY CONT	BATTERY BUS

B. Close the following circuit breakers:

CIRCUIT BREAKER	LOCATION
AUTOTHROTTLE 115 VAC	RADIO BUS 2
AUTOTHROTTLE OFF WARN LT	RADIO BUS 3
ANTI-SKID SYSTEM	DC BUSSES 1 & 4
GROUND SPOILER CONTROL	AC BUS 4
VERTICAL GYRO 1 (Aircraft N789FT and Subs)	LEFT AC EMER BUS
VERTICAL GYRO 2 (Aircraft N779FT through N788FT)	RIGHT AC EMER BUS

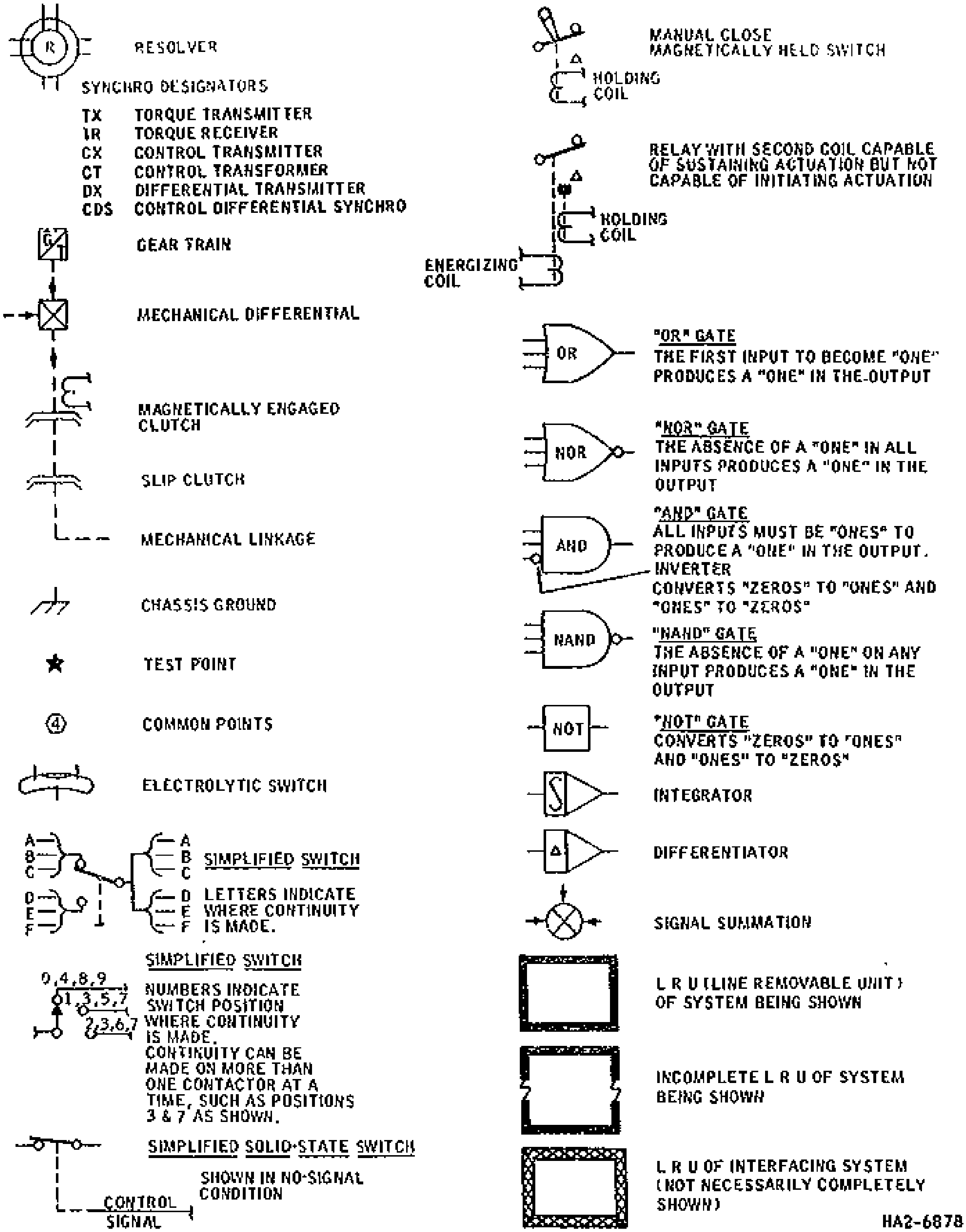
CIRCUIT BREAKER	LOCATION
AUX VERTICAL GYRO	RIGHT & LEFT AC EMER BUSSES
VERT GYRO TRANSFER	RIGHT DC EMER BUS
HORIZON DISPLAY (CAPT'S & F.O.)	RIGHT & LEFT AC EMER BUSSES
NAVIGATION INST XFMR 1 & 2	RADIO BUSSES 2 & 3
GO AROUND 1 & 2	RADIO BUSSES 2 & 3
RADIO BUS 2 LOAD MONITOR	RADIO BUS 2
RADIO BUS 3 LOAD MONITOR	RADIO BUS 3

5. Additional Throttle Response Problems

Possible Causes	Isolation Procedure	Correction
A. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective	Perform computer self-test procedure (see 22-30-1)	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle P10-770 bottom plug pins 22 & 32, and position sensor connector pins 5 & 4, respectively.	Replace sensor or repair wiring as necessary.

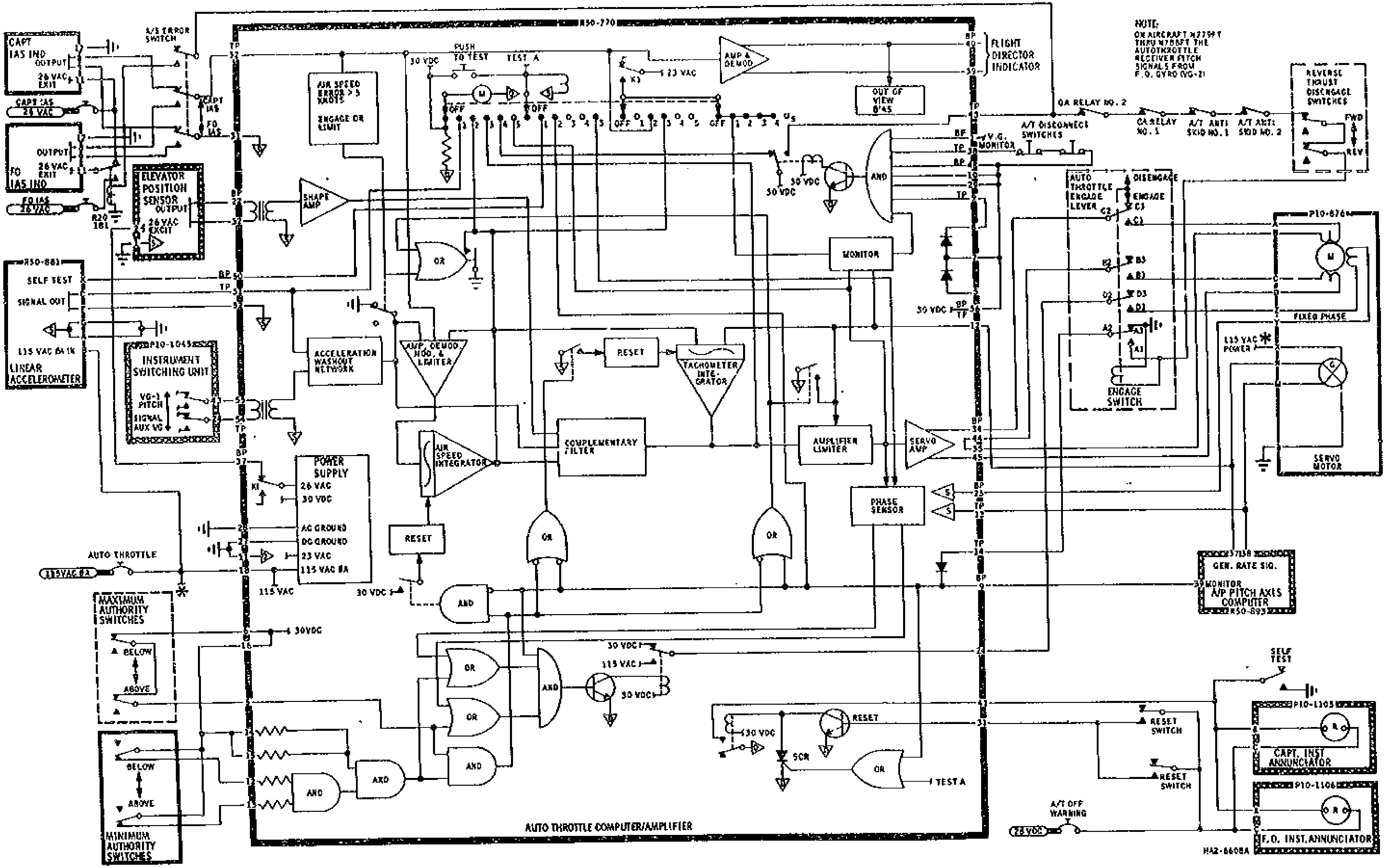
Possible Causes	Isolation Procedure	Correction
B.. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary.
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
C. AUTOTHROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

SCHEMATIC SYMBOLS NOT COVERED BY ATA 100



Schematic Symbols
Figure 101

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Auto Throttle System Schematic
Figure 102

Printed in U.S.A.

AUTOTHROTTLE OFF WARNING LIGHTS REMAIN ON

PROBABLE FAULT

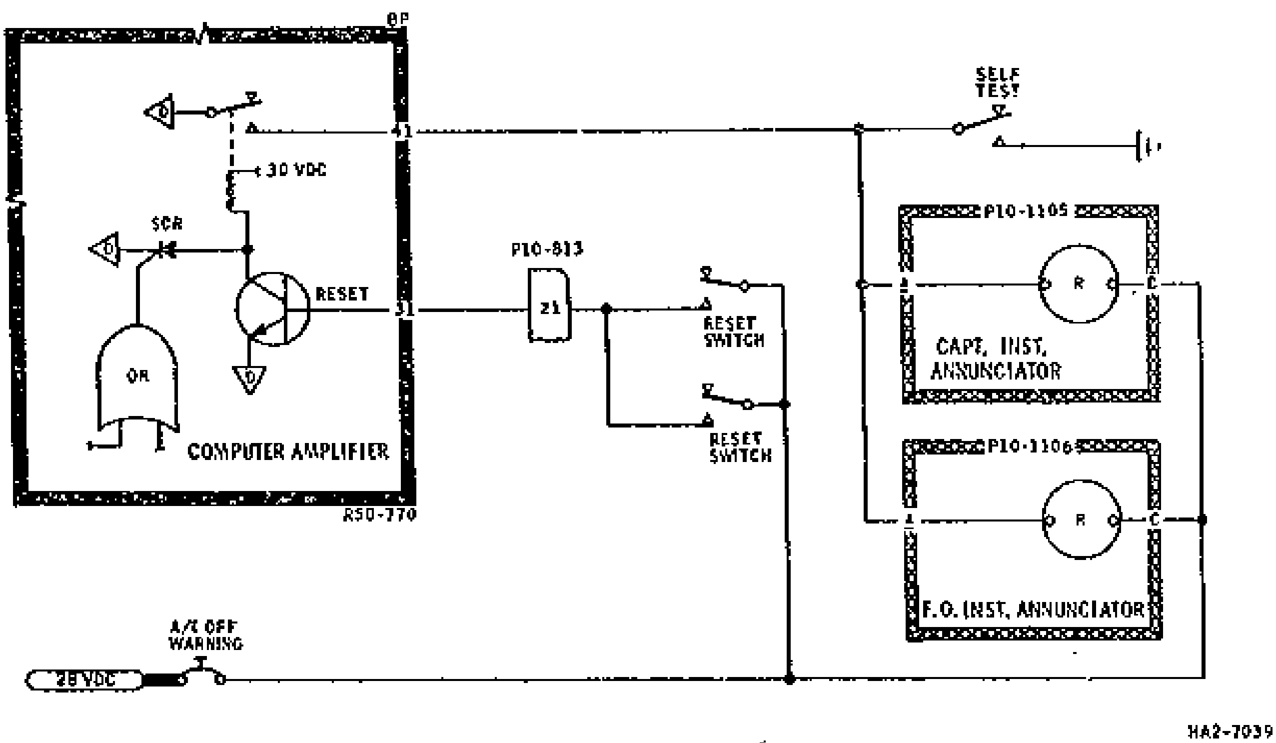
1. AUTOTHROTTLE COMPUTER.
2. AUTOTHROTTLE RESET SWITCHES.
3. DEFECTIVE WIRING.

PRESS AND RELEASE AUTOTHROTTLE RESET SWITCHES.

- LIGHT REMAINS ON

WITH AUTOTHROTTLE RELEASE SWITCHES OPEN. MEASURE 0 VDC AT P10-813 PIN 21 TO GROUND.

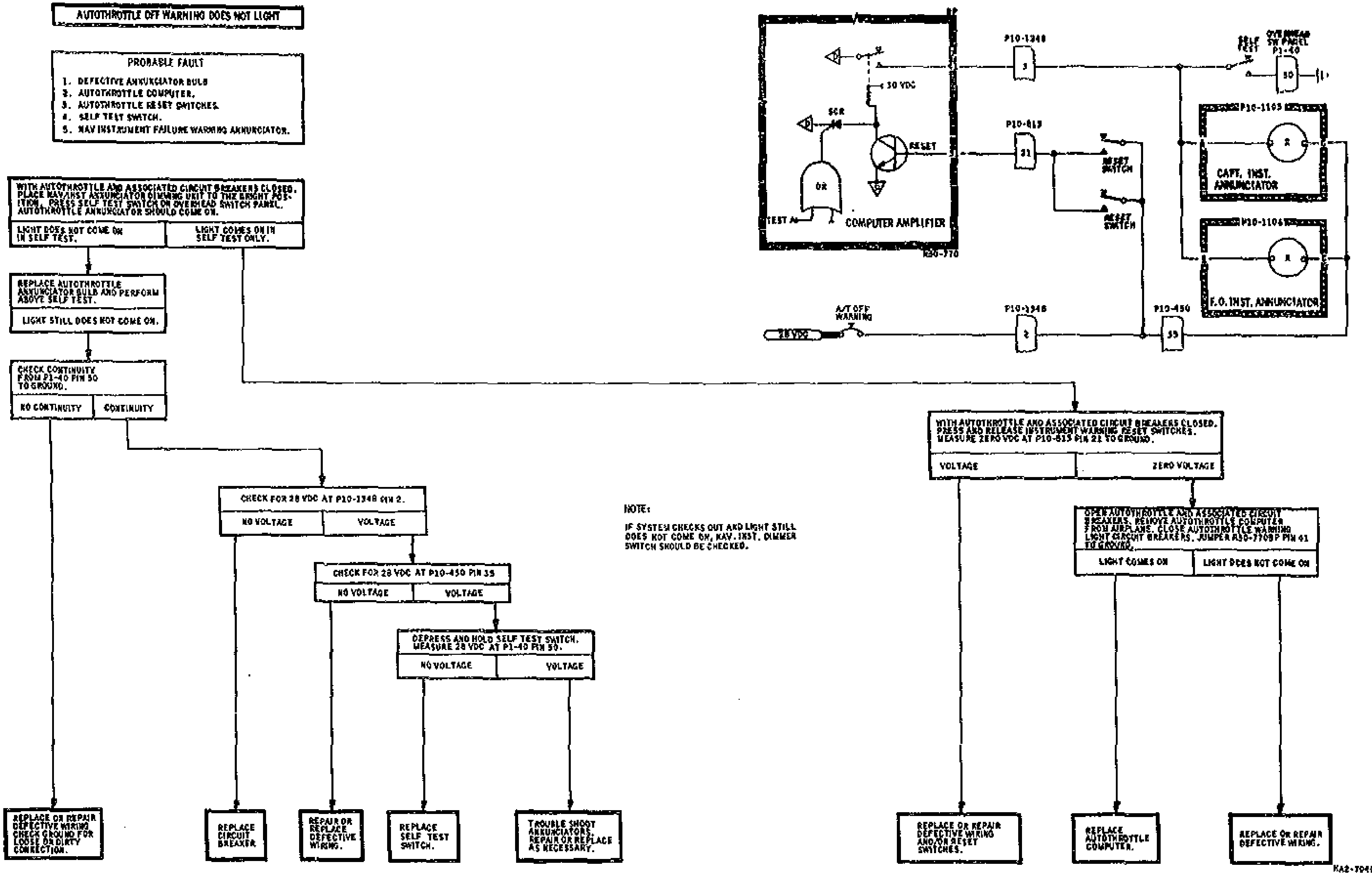
- VOLTAGE: REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE RESET SWITCHES.
- 0 VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKER. LIGHT SHOULD BE OUT.
  - LIGHT REMAINS ON: REPLACE OR REPAIR DEFECTIVE WIRING. (R50-770 PIN 41 THROUGH FAILURE WARNING ANNUNCIATORS). CHECK FOR SHORT CIRCUITS TO GROUND.
  - LIGHT GOES OUT: REPLACE AUTOTHROTTLE COMPUTER.



HA2-7039

Auto Throttle Off Warning Lights Remain On
Figure 103

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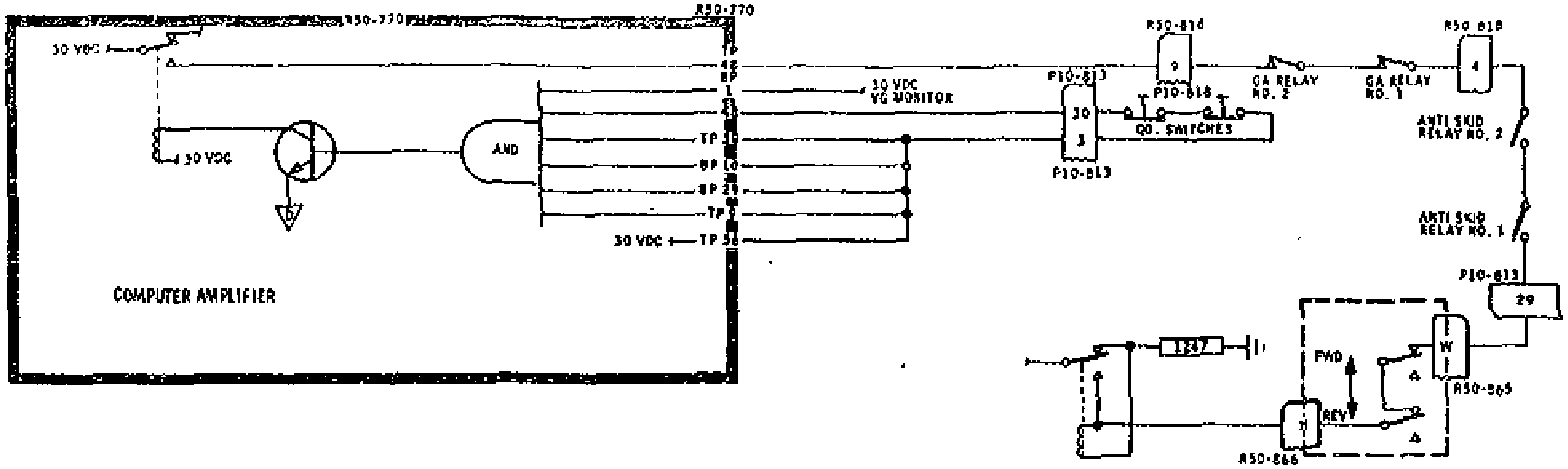


Auto Throttle Off Warning Lights Do Not Come On
Figure 104

AUTOTHROTTLE SYSTEM WILL NOT ENGAGE (AUTOTHROTTLE LEVER REMAINS LOCKED IN THE DISENGAGE POSITION.)

PROBABLE FAULT

1. AUTOTHROTTLE ENGAGE SWITCH.
2. AUTOTHROTTLE COMPUTER.
3. GO-AROUND MODE RELAYS.
4. AUTOTHROTTLE ANTI-SKID RELAYS.
5. THROTTLE DISENGAGE SWITCHES.

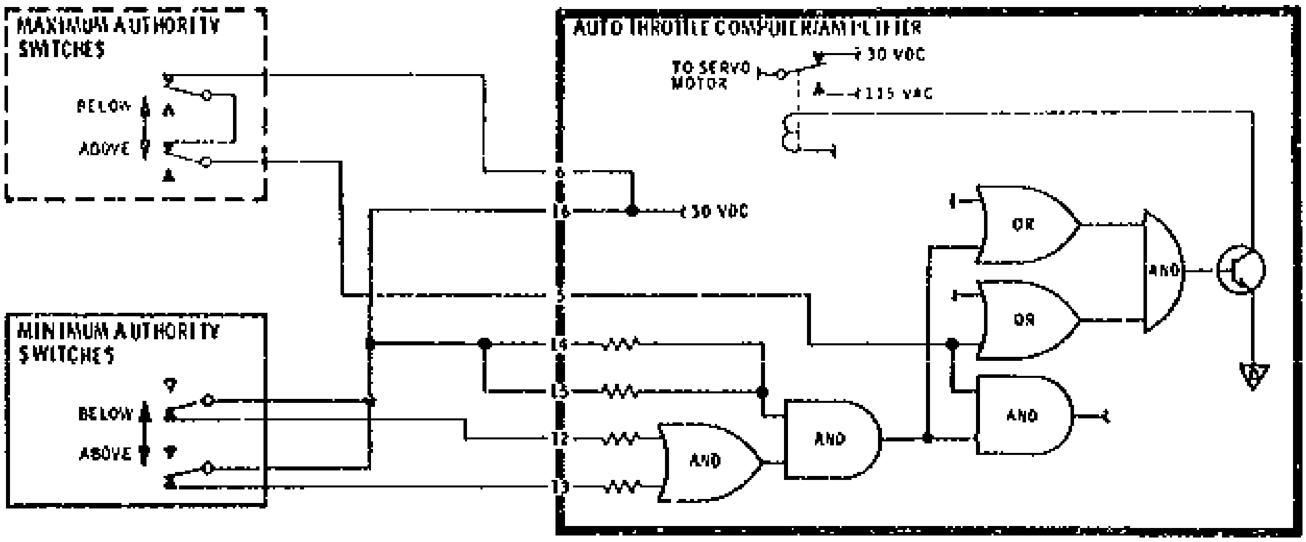


CLOSE ALL AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS.

CHECK 28 VDC AT P10-813 PIN 29.
- NO VOLTAGE → CHECK 28 VDC AT R50-818 PIN 4
  - VOLTAGE → REPAIR OR REPLACE ANTISKID SWITCHES AND/OR ASSOCIATED WIRING.
  - NO VOLTAGE → CHECK 28 VDC AT P10-818 PIN 9
    - VOLTAGE → REPAIR OR REPLACE G/A SWITCHES AND/OR ASSOCIATED WIRING.
    - NO VOLTAGE → OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS, AND REMOVE COMPUTER AMPLIFIER. CHECK CONTINUITY BETWEEN P10-770 PIN 48(TP), AND P10-818 PIN 9
      - CONTINUITY → VARIFY ENGAGE LOGIC CIRCUITS AS FOLLOWS:
        ON COMPUTER AMPLIFIER CHECK CONTINUITY BETWEEN THE FOLLOWING POINTS:
        1. R50-770 PIN 56(BP) TO PIN 9(TP).
        2. R50-770 PIN 56(BP) TO PIN 29(BP).
        3. R50-770 PIN 56(BP) TO PIN 10(BP).
        4. R50-770 PIN 56(BP) TO PIN 38(TP).
        5. R50-770 PIN 56(BP) TO PIN 48(BP).
        - CONTINUITY → CLOSE AUTO THROTTLE AND ASSOCIATED CIRCUIT BREAKERS AND CHECK 28 VDC AT P10-770 PIN 1 (BP). (VG MONITOR)
          - VOLTAGE → CHECK CONTINUITY BETWEEN P10-770 PIN 38(TP) AND PIN 48(BP). (THIS CHECKS OUT QUICK DISCONNECT SWITCHES).
            - CONTINUITY → REPLACE COMPUTER AMPLIFIER
            - NO CONTINUITY → REPAIR OR REPLACE QUICK DISCONNECT SWITCHES AND/OR ASSOCIATED WIRING AS NECESSARY.
          - NO VOLTAGE
        - NO CONTINUITY → REPLACE COMPUTER AMPLIFIER
      - NO CONTINUITY → REPAIR OR REPLACE DEFECTIVE WIRING
- VOLTAGE → CHECK 28 VDC AT R50-866 PIN H.
  - VOLTAGE → REMOVE WIRE Q303 AX 24N FROM GROUND STUD 1247,(RADIO RACK SHELF NO. 2) AND CHECK 28 VDC FROM WIRE TERMINAL TO GROUND.
    NOTE: IN EITHER CASE REPAIR OR REPLACE DEFECTIVE WIRING, AND/OR ENGAGE RELAY.
  - NO VOLTAGE → REPAIR OR REPLACE REVERSE THRUST SWITCHES AND ASSOCIATED WIRING.

HA2-7043

Auto Throttle System Will Not Engage
Figure 105



WITH AUTO THROTTLE ENGAGED, THROTTLE LEVERS DRIVE BEYOND ELECTRICAL STOPS.

PROBABLE CAUSES:

MINIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

MAXIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

IN WHICH DIRECTION DO THROTTLES DRIVE BEYOND LIMITS?

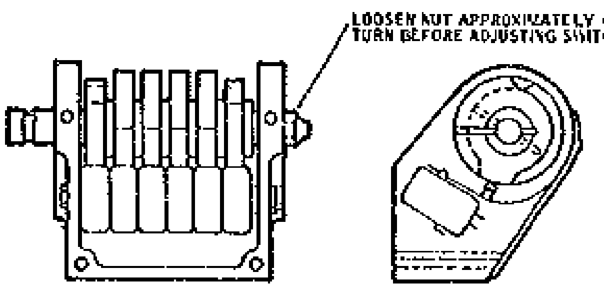
MAXIMUM	MINIMUM

MAXIMUM:

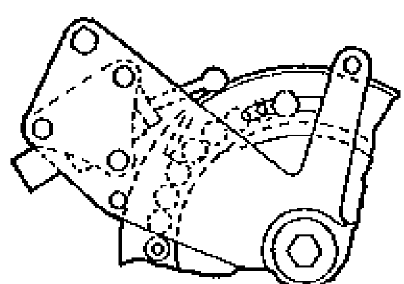
1. POSITION NUMBER 2 AND NUMBER 3 THROTTLE LEVER 3 13/16 ± 1/16 INCHES FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLER MOVES FROM LOW TO HIGH PORTION OF CAM.
3. TORQUE CAM SHAFT RETAINING NUT TO 60 INCH POUNDS AND SECURE WITH COTTER KEY.
4. VERIFY THAT SWITCHES DEACTUATE AT 3 13/16 INCHES FORWARD OF AFT STOP WHILE THROTTLES ARE MOVING IN POWER ON DIRECTION.

MINIMUM:

1. POSITION NUMBER 1 AND NUMBER 4 THROTTLE LEVER 1 INCH FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLERS MOVE FROM HIGH TO LOW PORTION OF CAM.
3. VERIFY THAT SWITCHES DEACTUATE 1 ± 1/16 INCHES FROM AFT STOP WHILE THROTTLE LEVERS ARE MOVING IN POWER OFF DIRECTION.



CAM ASSEMBLY-PEDESTAL THROTTLE SWITCHES



MINIMUM AUTHORITY SWITCH

HA2-7070

Auto Throttle Levers Drive Beyond Limits
Figure 106

AUTOTHROTTLE - TROUBLE SHOOTING

1. General

A. Trouble shooting procedures consist primarily of isolation of faulty components. In the case of autothrottle electronic components, this can sometimes be accomplished by self-test.

B. A thorough knowledge of the interrelationship of components is essential for meaningful trouble shooting. For this reason, an autothrottle and associated system interface simplified schematic is contained in this section.

C. A Trouble Shooting Index is provided in paragraph 3. This is to be utilized as an aid to isolate particular problem areas. When a problem arises, isolate the problem area, then use the referenced logic diagram to isolate the faulty component, or defective wiring.

D. Refer to paragraph 4 for location of circuit breakers that have a direct bearing on the operation of the autothrottle and associated systems.

E. Standard electrical voltages are given in the following procedures, however it is to be understood that a 10% tolerance is permissible unless otherwise stated.

2. Tools and Equipment Required

A. The following equipment or suitable substitute may be required during trouble shooting procedures:

Item	Name	Number	Manufacturer	Use
A	Volt-Ohm Meter	Model 260	Simpson	Used to read ac and dc voltages, and to check circuit continuity, and to measure resistance.

3. Trouble Shooting Index - Autothrottle System

A. The following table lists the malfunctions that are covered in this trouble shooting procedure:

	Malfunction	Figure No.
(1)	Autothrottle Off Warning Lights Remain On	103
(2)	Autothrottle Off Warning Lights Do Not Come On	104
(3)	Autothrottle System Will Not Engage	105
(4)	Throttle Levers Drive Beyond Electrical Stops	106

4. Circuit Breakers

A. Open the following circuit breakers:

CIRCUIT BREAKER	LOCATION
ALL FUEL BOOST PUMP	AC BUSSES 1, 2, 3, & 4
ENGINE STARTERS	BATTERY BUS
IGNITION PWR SUPPLY	BATTERY BUS
IGNITION PWR SUPPLY CONTROL	BATTERY BUS

B. Close the following circuit breakers:

CIRCUIT BREAKER	LOCATION
AUTOTHROTTLE 115 VAC	RADIO BUS 2
AUTOTHROTTLE OFF WARN LT	RADIO BUS 3
ANTI-SKID SYSTEM	DC BUSSES 1 & 4
GND SPOILER CONT	AC BUS 4

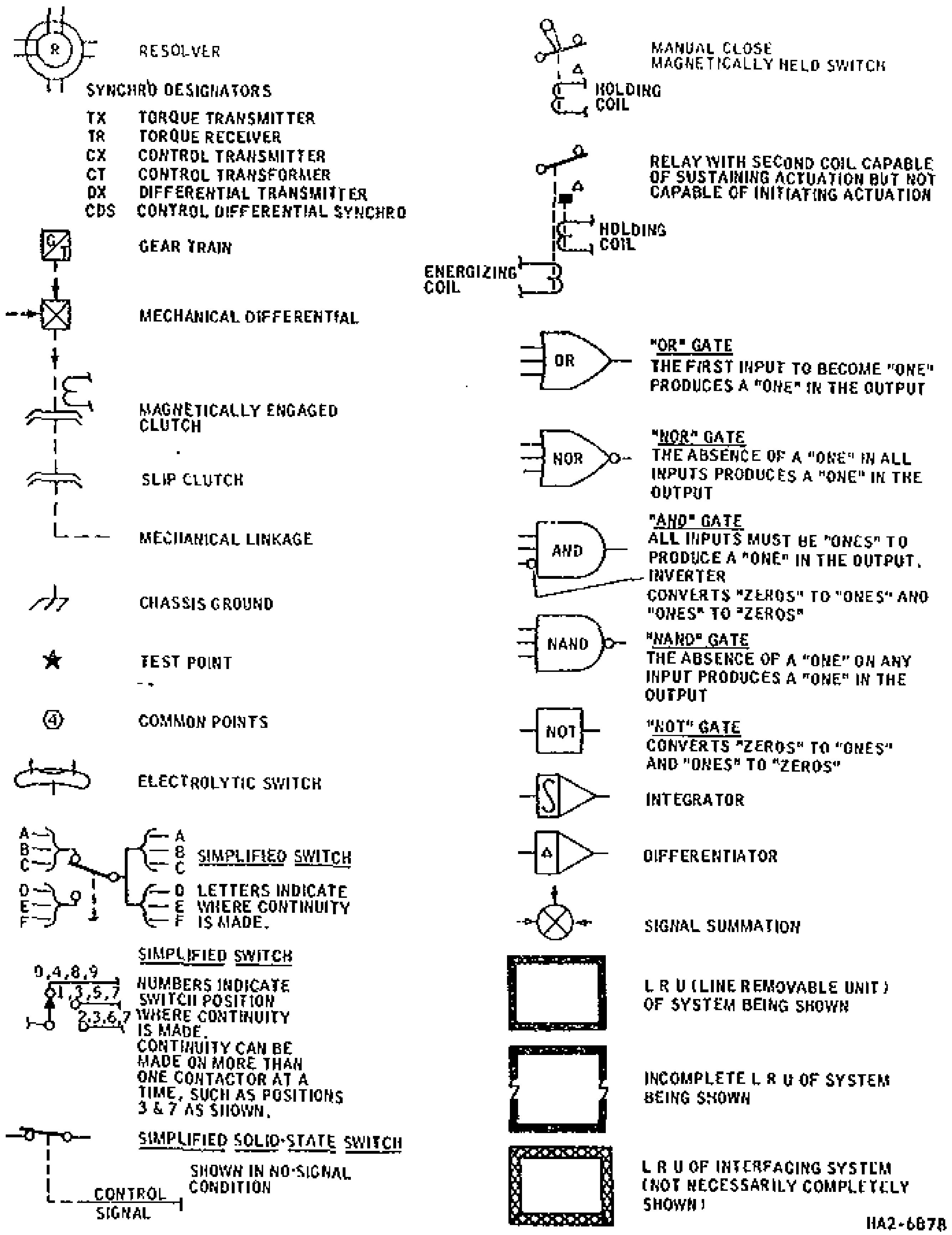
CIRCUIT BREAKER	LOCATION
HORIZON DISPLAY (CAPT'S)	LEFT AC EMER BUSSES
GO AROUND 1 & 2	RADIO BUSSES 2 & 3
RADIO BUS 2 LOAD MONITOR	RADIO BUS 2
RADIO BUS 3 LOAD MONITOR	RADIO BUS 3

5. Additional Throttle Response Problems

Possible Causes	Isolation Procedure	Correction
A. THROTTLES DO NOT RESPOND TO ELEVATOR MOVEMENT		
(1) Computer defective	Perform computer self-test procedure (see 22-30-1)	Replace computer.
(2) Position sensor defective.	Disconnect position sensor electrical connector and check for 26 vac between pins 1 and 2.	If zero vac check and repair wiring. If 26 vac replace sensor.
	Remove computer. Check for continuity between computer rack mounted receptacle P10-770 bottom plug pins 22 & 32, and position sensor connector pins 5 & 4, respectively.	Replace sensor or repair wiring as necessary.

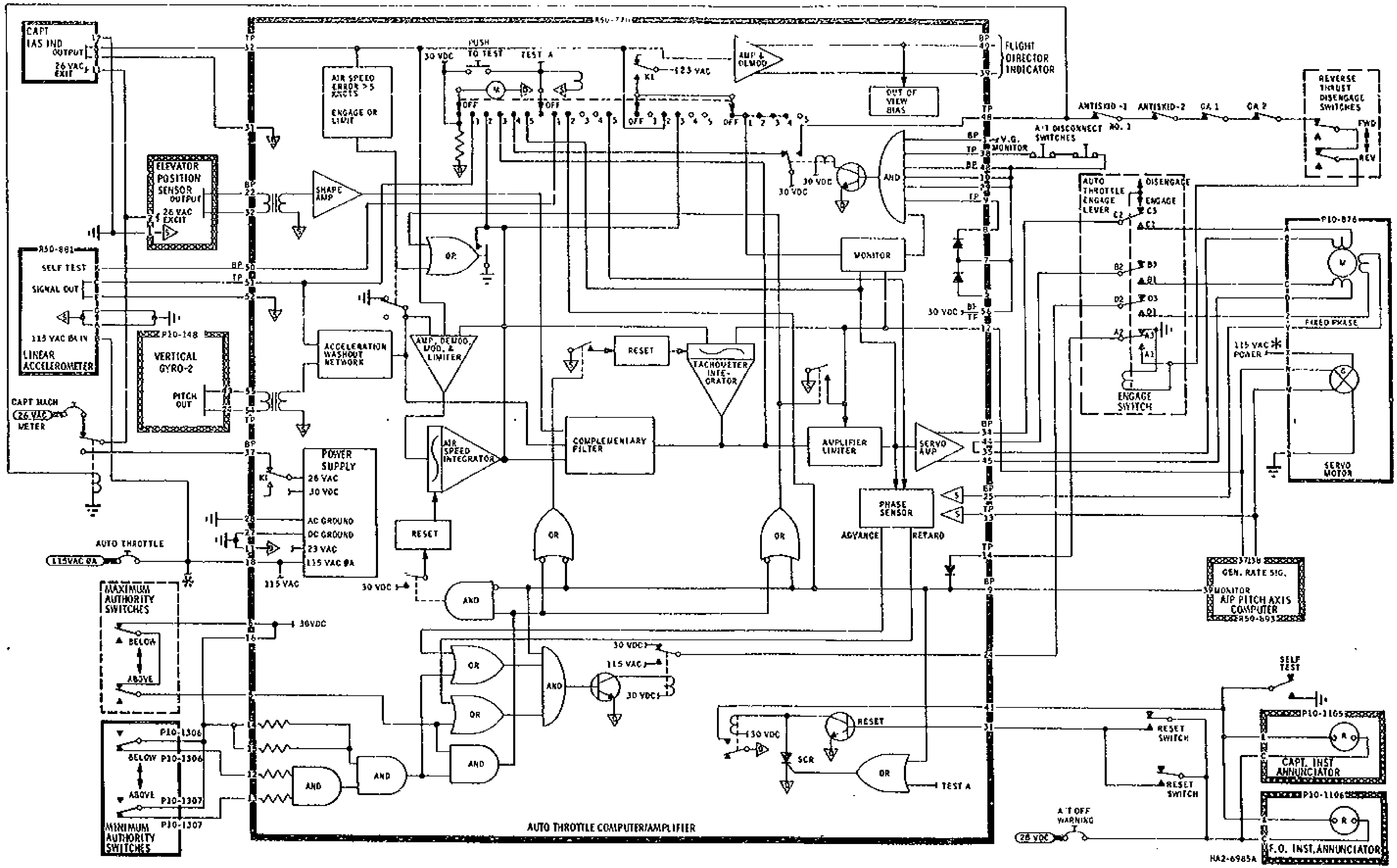
Possible Causes	Isolation Procedure	Correction
B. THROTTLES DO NOT MOVE TOGETHER (THROTTLES SEPARATE)		
(1) Throttle linkage out of adjustment.	Perform functional test of servo authority limits per 22-30-0, Maintenance Practices.	Adjust linkage as necessary.
(2) Throttle lever drive clutch defective.	Visually check affected throttle lever drive clutch for worn, broken, or bent input drive finger, or broken centering spring.	Replace drive clutch.
C. AUTOTHROTTLE DOES NOT DISENGAGE USING QUICK DISCONNECT BUTTON (QD)		
(1) QD defective.	Alternately depress QD on throttle levers 1 and 4.	Replace defective QD.
(2) Computer defective.	Perform computer self-test procedure (see 22-30-1).	Replace computer.

SCHEMATIC SYMBOLS NOT COVERED BY ATA 100



Schematic Symbols
Figure 101

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Autothrottle System Schematic
Figure 102

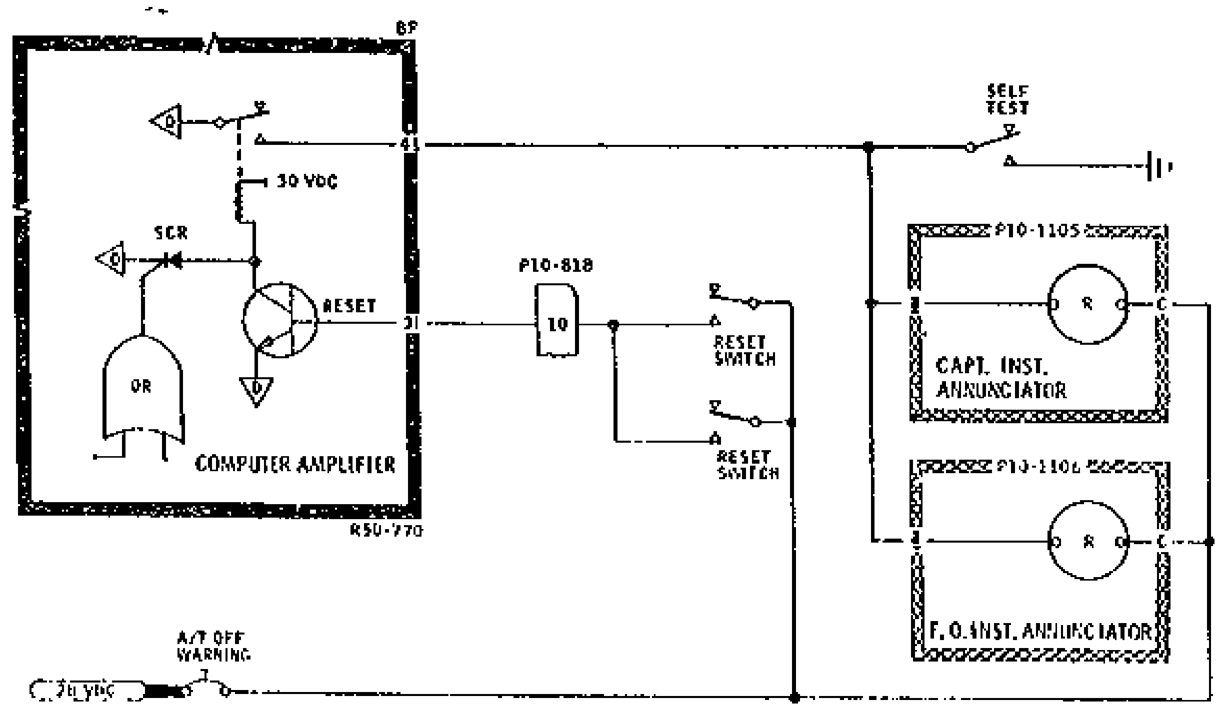
AUTOTHROTTLE OFF WARNING LIGHTS REMAIN ON

PROBABLE FAULT

1. AUTOTHROTTLE COMPUTER
2. AUTOTHROTTLE RESET SWITCHES.
3. DEFECTIVE WIRING.

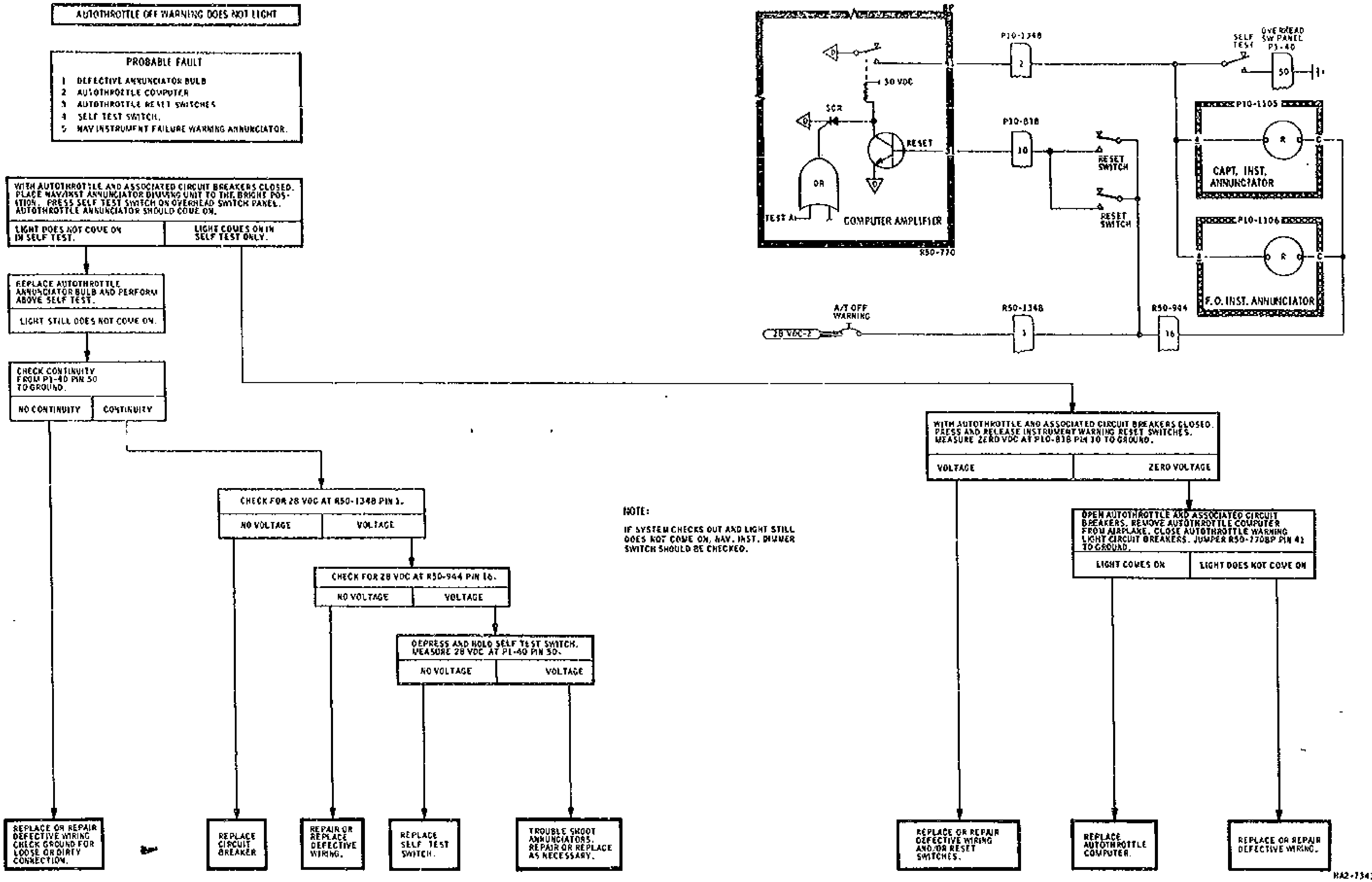
PRESS AND RELEASE AUTOTHROTTLE RESET SWITCHES.

- LIGHT REMAINS ON → WITH AUTOTHROTTLE RESET SWITCHES OPEN, MEASURE 0 VDC AT P10-818 PIN 10 TO GROUND.
  - VOLTAGE → REPLACE OR REPAIR DEFECTIVE WIRING. REPLACE AUTOTHROTTLE RESET SWITCHES.
  - 0 VOLTAGE → OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS. REMOVE AUTOTHROTTLE COMPUTER FROM AIRPLANE. CLOSE AUTOTHROTTLE WARNING LIGHT CIRCUIT BREAKER. LIGHT SHOULD BE OUT.
    - LIGHT REMAINS ON → REPLACE OR REPAIR DEFECTIVE WIRING. (R50-770 PIN 41 THROUGH FAILURE WARNING ANNUNCIATORS). CHECK FOR SHORT CIRCUITS TO GROUND.
    - LIGHT GOES OUT → REPLACE AUTOTHROTTLE COMPUTER.



Autothrottle Off Warning Lights Remain On
Figure 103

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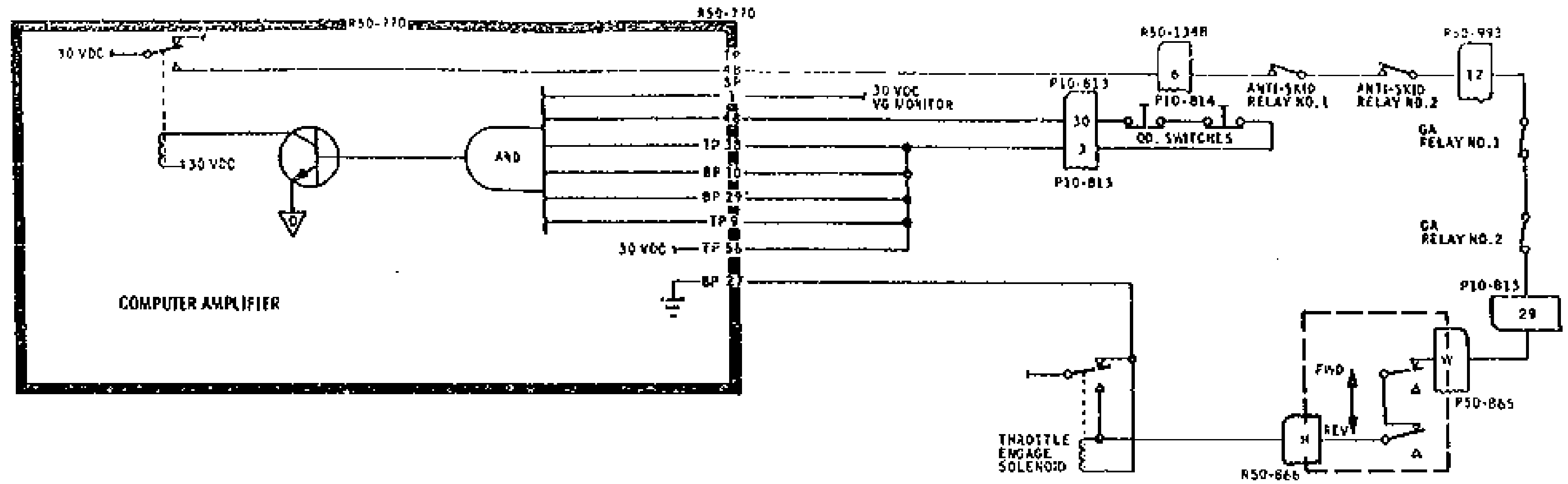


Autothrottle Off Warning Lights Do Not Light
Figure 104

AUTOTHROTTLE SYSTEM WILL NOT ENGAGE (AUTOTHROTTLE LEVER REMAINS LOCKED IN THE DISENGAGE POSITION)

PROBABLE FAULT

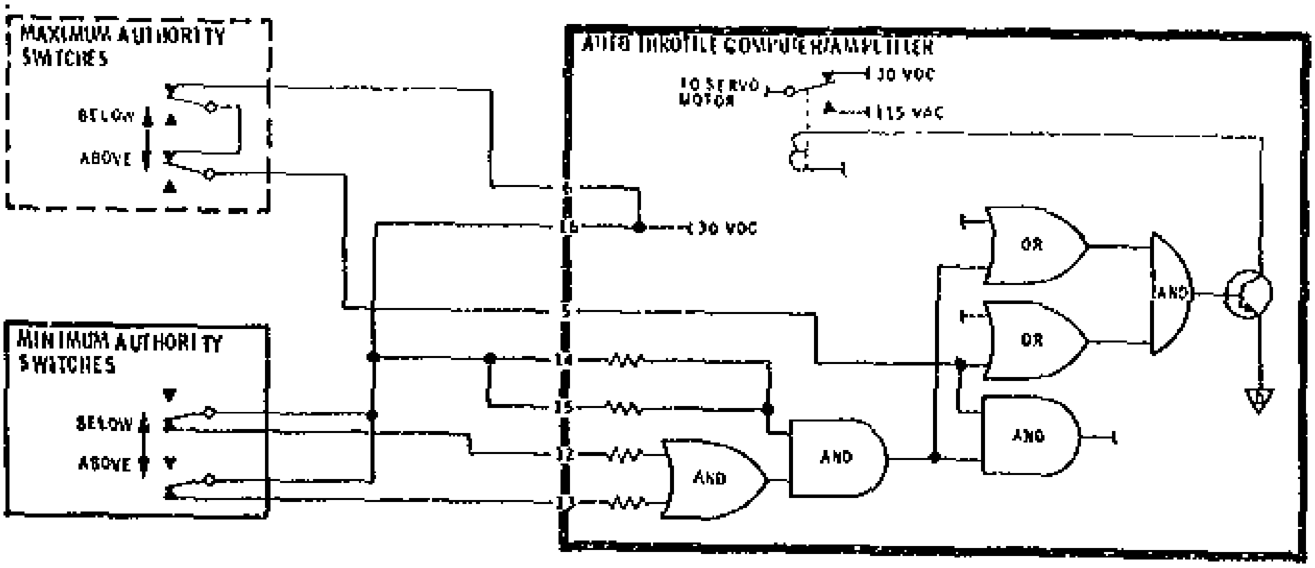
1. AUTOTHROTTLE ENGAGE SWITCH.
2. AUTOTHROTTLE COMPUTER.
3. GO-AROUND MODE RELAYS.
4. AUTOTHROTTLE ANTI-SKID RELAYS.
5. THROTTLE DISENGAGE SWITCHES.



- CLOSE ALL AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS.
- CHECK 28 VDC AT P10-813 PIN 29.
  - NO VOLTAGE: CHECK 28 VDC AT R50-993 PIN 12.
    - VOLTAGE: REPAIR OR REPLACE G/A SWITCHES AND/OR ASSOCIATED WIRING
    - NO VOLTAGE: CHECK 28 VDC AT P10-1348 PIN 6
      - VOLTAGE: REPAIR OR REPLACE ANTI-SKID SWITCHES AND/OR ASSOCIATED WIRING.
      - NO VOLTAGE: OPEN AUTOTHROTTLE AND ASSOCIATED CIRCUIT BREAKERS, AND REMOVE COMPUTER AMPLIFIER. CHECK CONTINUITY BETWEEN P10-770 PIN 48(TP), AND P10-814 PIN 6
        - CONTINUITY: VERIFY ENGAGE LOGIC CIRCUITS AS FOLLOWS:
          - ON COMPUTER AMPLIFIER CHECK CONTINUITY BETWEEN THE FOLLOWING POINTS:
            1. R50-770 PIN 56(BP) TO PIN 9(TP).
            2. R50-770 PIN 56(BP) TO PIN 29(BP).
            3. R50-770 PIN 56(BP) TO PIN 10(BP).
            4. R50-770 PIN 56(BP) TO PIN 38(TP).
            5. R50-770 PIN 56(BP) TO PIN 48(BP).
            - CONTINUITY: CLOSE AUTO THROTTLE AND ASSOCIATED CIRCUIT BREAKERS AND CHECK 29 VDC AT P10-770 PIN 1 (BP). (VG MONITOR)
              - VOLTAGE: CHECK CONTINUITY BETWEEN P10-770 PIN 38(TP) AND PIN 48(BP). (THIS CHECKS OUT QUICK DISCONNECT SWITCHES).
                - CONTINUITY: REPLACE COMPUTER AMPLIFIER
                - NO CONTINUITY: REPAIR OR REPLACE QUICK DISCONNECT SWITCHES AND/OR ASSOCIATED WIRING AS NECESSARY.
              - NO VOLTAGE: REPLACE COMPUTER AMPLIFIER
            - NO CONTINUITY: REPLACE COMPUTER AMPLIFIER
        - NO CONTINUITY: REPAIR OR REPLACE DEFECTIVE WIRING
  - VOLTAGE: CHECK 28 VDC AT R50-866 PIN H.
    - VOLTAGE: CHECK CONTINUITY BETWEEN R50-770 PIN 27 AND R50-866 PIN H.
      - CONTINUITY: REPLACE COMPUTER AMPLIFIER
      - NO CONTINUITY: REPAIR OR REPLACE LIMIT SWITCHES AND/OR ASSOCIATED WIRING
    - NO VOLTAGE: REPAIR OR REPLACE REVERSE THRUST SWITCHES AND ASSOCIATED WIRING

HA2-7344

Autothrottle Will Not Engage



WITH AUTO THROTTLE ENGAGED, THROTTLE LEVERS DRIVE BEYOND ELECTRICAL STOPS.

PROBABLE CAUSES:

MINIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

MAXIMUM AUTHORITY SWITCHES OUT OF ADJUSTMENT.

IN WHICH DIRECTION DO THROTTLES DRIVE BEYOND LIMITS?

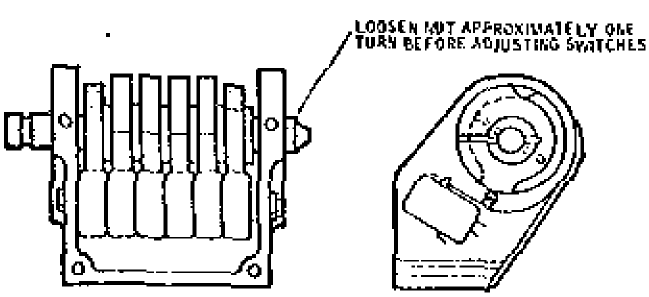
MAXIMUM	MINIMUM

MAXIMUM

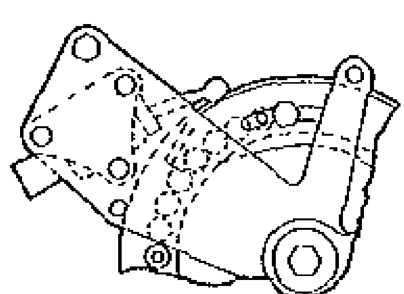
1. POSITION NUMBER 2 AND NUMBER 3 THROTTLE LEVER 3 13/16 ± 1/16 INCHES FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLER MOVES FROM LOW TO HIGH PORTION OF CAM.
3. TORQUE CAM SHAFT RETAINING NUT TO 60 INCH POUNDS AND SECURE WITH COTTER KEY.
4. VERIFY THAT SWITCHES DEACTUATE AT 3 13/16 INCHES FORWARD OF AFT STOP WHILE THROTTLES ARE MOVING IN POWER ON DIRECTION.

MINIMUM

1. POSITION NUMBER 1 AND NUMBER 4 THROTTLE LEVER 1 INCH FORWARD OF AFT STOP.
2. ADJUST CAMS BY LOOSENING CAM SHAFT NUT AND ROTATING CAMS TO DEACTUATE AS SWITCH ROLLERS MOVE FROM HIGH TO LOW PORTION OF CAM.
3. VERIFY THAT SWITCHES DEACTUATE 1 ± 1/16 INCHES FROM AFT STOP WHILE THROTTLE LEVERS ARE MOVING IN POWER OFF DIRECTION.



CAM ASSEMBLY-PEDESTAL THROTTLE SWITCHES



MINIMUM AUTHORITY SWITCH

HAF-2070

Throttle Levers Drive Beyond Limits
Figure 106

AUTO THROTTLE - MAINTENANCE PRACTICES

1. General

   A. The auto throttle control system tests consist of an operational (preflight) check and a functional test.

   B. The operational (preflight) check determines acceptable operation of the engage/disengage interlocks and the output of the speed command computer. The preflight check requires no tools or equipment or access to system components.

   C. The functional test procedures require access to the speed command computer and the auto throttle computer/amplifier, both located in the flight compartment radio rack. The functional test should be performed after extensive overhaul of the auto throttle control system or when a system malfunction is suspected.

   D. The speed command system associated with the auto throttle control system should be previously checked out and functioning properly.

2. Tools and Equipment Required

   A. The complete functional test requires a ruler or measuring tape to measure throttle lever movement in inches along the top curved surface of the center pedestal cover plate (see Figure 201).

3. Adjustment/Test Auto Throttle Control System (Operational)

   A. Test Auto Throttle Control System

      (1) Depressurize hydraulic system (see Chapter 29).

      (2) Open following circuit breakers located on EPC circuit breaker panel:

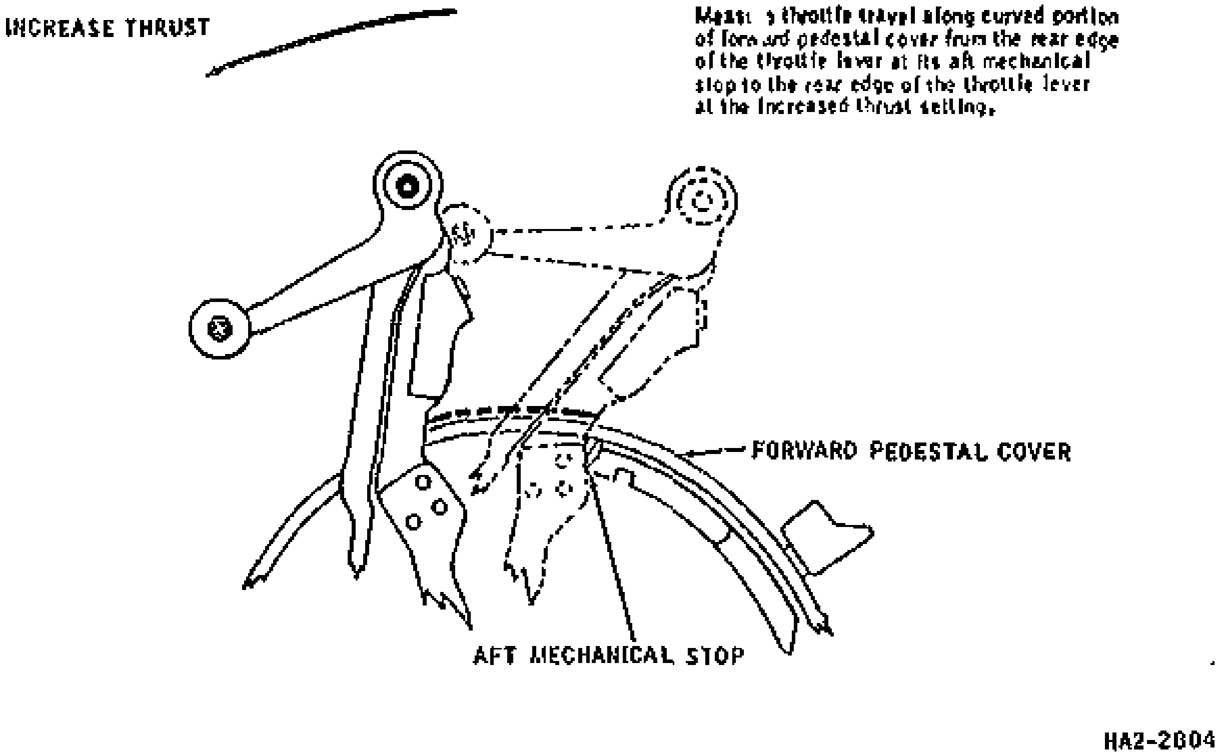
         (a) All fuel boost pump circuit breakers.

         (b) All engine start pump circuit breakers.

         (c) All engine ignition circuit breakers.

      (3) If throttle lights on captain's and first officer's failure warning annunciators are on, press either captain's or first officer's instrument warning reset button. Lights should go off.

      (4) Place captain's flight director system in go-around mode. Captain's speed command mode annunciator, located on upper instrument panel, should indicate T/O (take-off); fast-slow indicator, located on captain's flight director indicator should be away from center towards



Measurement Guide -- Throttle Lever Travel
Figure 201

slow legend; speed command flag on captain's flight director indicator should be retracted from view.

(5) Check that auto throttle lever cannot be moved from disengage position.

(6) Place captain's flight director system in any mode except off or go-around, and open both ground control relay circuit breakers. In approximately 15 seconds, captain's speed command mode annunciator should indicate APPR (approach); fast-slow indicator should remain on slow side.

WARNING: NORMAL ELECTRICAL POWER SUPPLY TO VARIOUS SYSTEMS IS INTERRUPTED WHEN GROUND CONTROL CIRCUIT BREAKERS ARE OPENED. MAKE CERTAIN THAT SWITCHES AND CONTROLS OF AFFECTED SYSTEMS ARE IN CORRECT POSITIONS TO PREVENT INADVERTENT OPERATION OR SHUTDOWN OF EQUIPMENT.

(7) Manually place all throttles in approximate idle position and move auto throttle lever to engage position. Lever should hold; throttles should move forward.

(8) Manually place and hold all throttles in high thrust.

(9) Place and hold speed command test switch, located on forward overhead switch panel in fast position and release throttle levers. Fast-slow indicator should move into fast region; throttles should move aft to approximately 1 inch forward of aft stop.

(10) Continue to hold switch in fast position and manually move all throttles to aft stop. Throttles should hold.

(11) Place and hold speed command test switch in slow position. Fast-slow indicator should move into slow region; all throttles should move forward. It should be possible to manually overpower and move throttle levers in opposite direction with force no greater than that required in a disengage system. Release test switch.

(12) Manually move all throttle levers through their entire range from aft stop to forward stop. Auto throttle lever should hold in engage position.

(13) Press auto throttle disengage button on left side of No. 1 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

(14) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(15) Press auto throttle disengage button on right side of No. 4 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

(16) Move auto throttle lever to engage position, then return lever to disengage position. Throttle warning lights should go off momentarily and come back on when auto throttle is disengaged.

(17) With all throttle levers in midrange position, move auto throttle lever to engage position. Lever should hold.

(18) Open auto throttle computer circuit breaker. Auto throttle lever should move to disengage position; throttle lights should come on.

(19) Check that auto throttle lever cannot be moved from disengage position.

(20) Close auto throttle computer circuit breaker. Auto throttle lights should go off and it should be possible to reengage auto throttle.

(21) Open speed command computer circuit breaker. Auto throttle lever should move to disengage position; throttle lights should come on; flag on captain's flight director indicator should come into view.

(22) Check that auto throttle lever cannot be moved from disengage position.

(23) Close speed command computer circuit breaker. Flag on flight director indicator should retract from view and it should be possible to reengage auto throttle.

(24) Move and hold throttle levers at aft stops.

(25) Slowly move either No. 2 or No. 3 reverse thrust lever towards reverse thrust. Before reverse thrust lever is approximately 5-1/4 inches above pedestal cover, auto throttle lever should move to disengage position.

(26) Place reverse thrust lever in normal forward thrust position and move all throttle levers to midrange position.

(27) Place auto throttle lever in engage position.

(28) Place captain's flight director system in go-around mode. Captain's speed command mode annunciator should indicate go-around (GO ARND); auto throttle lever should move to disengage position.

(29) Check that auto throttle lever cannot be moved from disengage position.

(30) Place flight director system in any mode except off or go-around.

(31) Place auto throttle lever in engage position.

(32) Close both ground control relay circuit breakers. In approximately 4 seconds, captain's speed command mode annunciator should indicate takeoff. When mode annunciator indicates takeoff, auto throttle engage lever should move to disengage position; throttle lights should come on.

(33) Move all throttle levers to aft stops.

(34) Close following circuit breakers located on EPC circuit breaker panel:

(a) All fuel boost pump circuit breakers.

(b) All engine start pump circuit breakers.

(c) All engine ignition circuit breakers.

4. Adjustment/Test Auto Throttle Control System (Functional)

A. Test Auto Throttle Control System

NOTE: The flaps should be in full up position and the throttle systems should be rigged and in working order before performing the following procedures.

(1) Depressurize hydraulic system (see Chapter 29).

(2) Open fol'owing circuit breakers located on EPC circuit breaker panel:

(a) All fuel boost pump circuit breakers.

(b) All engine start pump circuit breakers.

(c) All engine ignition circuit breakers.

(d) Speed command computer circuit breaker.

NOTE: Steps (3 through 37) test the engage interlocks.

(3) Remove speed command computer located in accessory compartment.

(4) Connect jumper between pins 3 and 4 of speed command computer top electrical connector.

(5) Connect jumper between pins 2 and 30 of bottom electrical connector.

(6) Close speed command computer circuit breaker.

(7) If throttle lights on failure warning annunciators are on, press captain's or first officer's instrument warning reset button. Lights should go off.

(8) With all throttle levers in approximate center position, move auto throttle lever located on forward pedestal to engage position. Lever should hold; throttles should not move.

(9) Manually move all throttle levers through entire range from aft stop to forward stop. Auto throttle lever should hold in engage position.

(10) Press auto throttle disengage button on left side of No. 1 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

(11) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(12) Press auto throttle disengage button on right side of No. 4 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

(13) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(14) Move No. 2 throttle lever to aft stop and slowly move reverse thrust lever toward reverse thrust. Before reverse thrust lever is 5-1/4 (±1/16) inches above pedestal cover, auto throttle lever should move to disengage position and throttle lights should come on.

(g) Open both ground control relay circuits breakers. Auto throttle lever should move to disengage position; throttle lights should come on.

(27) On airplanes N8762-N8778, test anti-skid/auto throttle interlock as follows:

(a) Open both ground control relay circuit breakers located on EPC circuit breaker panel. Auto throttle lever should remain in engage position; throttle lights should not come on.

WARNING: NORMAL ELECTRICAL POWER SUPPLY TO VARIOUS SYSTEMS WILL BE INTERRUPTED WHEN GROUND CONTROL RELAY CIRCUIT BREAKERS ARE OPENED. MAKE CERTAIN THAT SWITCHES AND CONTROLS OF AFFECTED SYSTEMS ARE IN CORRECT POSITIONS TO PREVENT INADVERTENT OPERATION OR SHUTDOWN OF EQUIPMENT.

(b) Open anti-skid system control circuit breaker.

(c) Remove jumper from anti-skid control box electrical connector and install jumper between pins 29 and 32.

(d) Close anti-skid system control circuit breaker. Auto throttle lever should remain in engage position.

(e) Move auto throttle lever to disengage position.

(28) through (32) Deleted.

(33) Close both ground control relay circuit breakers.

(34) Open anti-skid system control circuit breaker.

(35) Remove jumper from anti-skid control box electrical connector.

(36) Install anti-skid control box.

(37) Close ground spoiler control and anti-skid system control circuit breakers.

NOTE: Steps (38 through 66) test the self-test capability of the auto throttle computer/amplifier.

(38) Position throttle levers at midrange position.

(39) Place self-test selector switch, located on auto throttle computer/amplifier, in fixed phase position. Self-test meter should indicate less than 1 scale division.

(40) Move auto throttle lever to engage position. Lever should hold; self-test meter should indicate in green range.

(41) Move all throttle levers to approximately 1 inch forward of aft stops.

(42) Press and hold advance (ADV) switch. With all throttle levers moving forward, self-test meter indication should remain in green range.

NOTE: Throttle levers must be in motion between minimum authority limit (1 (±1/16) inch forward of aft stop) and maximum authority limit (3-13/16 (±1/16) inches forward of aft stop) to obtain correct self-test meter indications.

(43) Release advance switch. Self-test meter indication should remain in green range.

(44) Press and hold retard (RET) switch. With all throttle levers moving aft. self-test meter indication should remain in green range.

(45) Release retard switch. Self-test meter indication should remain in green range.

(46) Place self-test switch in amplifier output (AMP OUT) position.

(47) Press and hold advance switch. With all throttles levers moving forward, self-test meter indication should be in yellow range.

(48) Release advance switch. Self-test meter indication should be less than 1 scale division.

(49) Press and hold retard switch. With all throttle levers moving aft, self-test meter indication should be in yellow range.

(50) Release retard switch. Self-test meter indication should be less than 1 scale division.

(51) Place self-test switch in tachometer (TACH) position.

(52) Press and hold advance switch. With all throttle levers moving forward, self-test meter indication should be in green range.

(53) Release advance switch. Self-test meter indication should be zero.

(54) Press and hold retard switch. With all throttle levers moving aft, self-test meter indication should be in green range.

(55) Release retard switch. Self-test meter indication should be zero.

(56) Open autothrottle circuit breaker, located on EPC circuit breaker panel. Auto throttle lever should move to disengage position; throttle lights should come on.

(57) Check that auto throttle lever cannot be moved from disengage position.

(58) Close autothrottle circuit breaker.

(59) Place self-test switch in alarm position.

(60) Press and hold phase test (P TEST) switch. Meter indication should move from green range to zero in approximately 3 seconds.

(61) Check that auto throttle lever cannot be moved from disengage position. Release phase test switch.

(62) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(63) Move all throttle levers to aft stop.

(64) Press and hold retard and phase test switches. Meter indication should move from green range to zero in approximately 3 seconds; auto throttle lever should move to disengage position; throttle lights should come on. Release retard and phase test switches.

(65) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(66) With all throttle levers positioned at forward stops, press and hold advance and phase test switches. Meter indication should move from green range to zero in approximately 3 seconds; auto throttle lever should move to disengage position; throttle lights should come on. Release advance and phase test switches.

NOTE: Steps (67 through 80) test the servo authority limit.

(67) Move all throttle levers to aft stops.

(68) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(69) Press and hold advance switch. All throttle levers should move forward and stop 3 13/16 (±17/64) inches forward of aft stop. Hold switch while performing steps (70 through 72).

NOTE: If all throttle levers do not move forward from identical positions, discrepancies in lever positions will exist when forward motion stops.

(70) Move No. 2 throttle lever to aft stop. Throttle levers 1, 3, and 4 should not move from position obtained in step (69).

(71) Align No. 2 throttle lever with remaining throttle levers.

(72) Move No. 3 throttle lever to aft stop. Throttle levers 1, 2, and 4 should not move.

(73) Release advance switch.

(74) Move all throttle levers to approximately 3 3/8 inches forward of aft stop.

(75) Press and hold retard switch. All throttle levers should move aft and stop 1 (±17/64) inch forward of aft stop.

NOTE: If all throttle levers do not move aft from identical positions, discrepancies in lever positions will exist when aft motion stops.

(76) Move and hold No. 1 throttle lever at approximately 2 19/32 inches forward of aft stop. Throttle levers 2, 3, and 4 should move to aft stop. Release retard switch.

(77) Move all throttle levers to approximately 1 inch forward of aft stop.

(78) Move and hold No. 4 throttle lever at approximately 2 19/32 inches forward of aft stop.

(79) Press and hold retard switch. Throttle levers 1, 2, and 3 should move to aft stop. Release retard switch.

(80) Move auto throttle lever to disengage position. Throttle lights should come on.

NOTE: Steps (81 through 86) test the overpower function.

(81) Move all throttle levers to approximately 1 3/4 inches forward of aft stop.

(82) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(83) Press and hold advance switch. As throttle levers move forward, check that forward motion can be stopped by manually holding throttle levers. Release advance switch.

(84) Move all throttle levers to approximately 2 19/32 inches forward of aft stop.

(85) Press and hold retard switch. As throttle levers move aft, check that aft motion can be stopped by manually holding throttle levers. Release retard switch.

(86) Move auto throttle lever to disengage position. Throttle lights should come on.

NOTE: Steps (87 through 119) test the speed command computer interlock.

(87) Open speed command computer circuit breaker.

(88) Remove jumper from top and bottom speed command computer electrical connectors.

(89) Install speed command computer.

(90) Close speed command computer circuit breaker.

(91) Move all throttle levers to aft stop.

(92) Place captain's flight director system in go-around (GA) mode. Captain's speed command mode (SPD CMD MODE) annunciator, located on upper instrument panel should indicate takeoff (T/O); speed command flag on captain's flight director indicator should be retracted from view.

(93) Check that auto throttle lever cannot be moved from disengage position.

(94) Place captain's flight director system in any mode except off or go-around.

(95) Open both ground control relay circuit breakers. Captain's speed command mode annunciator should indicate approach (APPR) in approximately 15 seconds.

WARNING: NORMAL ELECTRICAL POWER SUPPLY TO VARIOUS SYSTEMS WILL BE INTERRUPTED WHEN GROUND CONTROL RELAYS ARE OPENED. MAKE CERTAIN IN THAT SWITCHES AND CONTROLS OF AFFECTED SYSTEMS ARE IN CORRECT POSITIONS TO PREVENT INADVERTENT OPERATION OR SHUTDOWN OF EQUIPMENT.

(96) Close ground control relay circuit breakers. Captain's speed command mode annunciator should indicate takeoff (T/O) in approximately 4 seconds.

(97) Position all throttle levers at approximately 3 11/16 inches forward of aft stops.

(98) Open both ground control relay circuit breakers. Wait at least 30 seconds before proceeding to next step.

(99) Slowly move throttle levers toward aft stops. When throttle levers are 2 1/2 (±7/16) inches from aft stop, captain's speed command mode annunciator should indicate approach.

(100) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

NOTE: When the auto throttle lever is moved to the engage position, the auto throttle servo drive may attempt to drive the throttle levers. If this occurs, manually hold the throttle levers at the aft stop.

(101) Open speed command computer circuit breaker. Auto throttle lever should move to disengage position, throttle lights should come on.

(102) Check that auto throttle lever cannot be moved from disengage position.

(103) Disconnect electrical connector from speed command accelerometer, located in accessory compartment.

(104) Close speed command computer circuit breaker.

(105) Check that auto throttle lever cannot be moved from disengage position.

(106) Open speed command computer circuit breaker.

(107) Connect electrical connector to speed command accelerometer.

(108) Remove lift data computer located in accessory compartment.

(109) Close speed command computer circuit breaker.

(110) Check that auto throttle lever cannot be moved from disengage position.

(111) Open speed command computer circuit breaker.

(112) Install lift data computer.

(113) Close speed command computer circuit breaker.

(114) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(115) Open first officer's horizon circuit breaker located on emergency bus section of EPC circuit breaker panel. Auto throttle lever should move to disengage position; throttle lights should come on.

(116) Close first officer's horizon circuit breaker.

(117) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(118) Place captain's flight director system in go-around mode. Captain's speed command mode annunciator should indicate go-around (GO ARND); auto throttle lever should move to disengage position; throttle lights should come on.

NOTE: The speed command flag on the captain's flight director indicator must be retracted from view.

(119) Place captain's flight director system in any mode except off or go-around. Captain's speed command mode annunciator should indicate approach.

NOTE: Steps (120 through 136) test the speed command computer output.

(120) Note that fast-slow indicator located on captain's flight director indicates toward slow legend.

(121) Move all throttle levers to aft stops.

(122) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off; all throttle levers should move forward at maximum rate to 1 (±1/4) inch forward of aft stop, then continue forward at maximum or decreased rate.

(123) Move and hold all throttle levers at approximately 3 3/8 inches forward of aft stops.

(124) Place and hold speed command test switch, located on forward overhead switch panel, in fast position. Release all throttle levers. All throttle levers should move aft and stop 1 (±1/16) inch forward of aft stop. Release test switch.

NOTE: If all throttle levers do not move aft from identical positions discrepancies in lever positions will exist when aft motion stops. Measurement should be made at the back of the most forward throttle lever.

(125) Move all throttle levers to aft stop. All levers should remain at aft stop.

(126) Hold throttle levers at aft stops.

(127) Place and hold speed command test switch in slow position and press and hold tachometer excitation self-test switch. Auto throttle lever should move to disengage position in approximately 3 seconds.

(128) Release tachometer excitation switch and throttle levers.

(129) Place auto throttle lever in engage position. All throttle levers should move forward at maximum rate to 1 (±1/4) inch forward of aft stops, then continue forward at maximum or decreased rate and stop 3 13/16 (±1/4) inches from aft stops.

(130) Position and hold throttle levers approximately 2 1/2 inches forward of aft stops.

(131) Press and hold tachometer excitation self-test switch. Auto throttle lever should move to disengage position in approximately 3 seconds.

(132) Release tachometer excitation self-test switch.

(133) Place auto throttle lever in engage position.

(134) Place and hold speed command test switch in fast position and press and hold tachometer excitation self-test switch. Auto throttle lever should move to disengage position in approximately 3 seconds.

(135) Release tachometer excitation self-test switch, speed command test switch, and throttle levers.

(136) Close both ground control relay circuit breakers. Captain's speed command mode annunciator should indicate takeoff in approximately 4 seconds, then auto throttle lever should move to disengage position; throttle lights should come on.

(137) Press captain's or first officer's instrument warning reset switch. Throttle lights should go off.

(138) Move all throttle levers to aft stop.

(139) Close following circuit breakers located on EPC circuit breaker panel:

(a) All fuel boost pump circuit breakers.

(b) All engine ignition circuit breakers.

(c) All engine start pump circuit breakers.

AUTOTHROTTLE - MAINTENANCE PRACTICES

1. General

A. This section contains a series of cockpit functional tests.

B. Should any of these tests fail, refer to the applicable trouble shooting section for corrective action.

2. Tools and Equipment Required

NOTE: Suitable substitutes may be used in lieu of the following listed items.

Item	Name	Number	Manufacturer	Use
A	SIMULATOR, Pitot & STATIC	VPT-10C	International Dynamics Corp.	To supply air speed reference to the airspeed indicator.
B	Measuring tape, or Flexible rule			Measure throttle lever movement along curved surface of control pedestal.

3. Preliminary Test Requirements

A. Rigging of fuel control system and engine throttles should be complete and in working order.

B. The airspeed control system associated with the Autothrottle System should be checked out previously and in working order.

C. Remove hydraulic power from airplane.

D. Open the following circuit breakers and have them remain open throughout this test procedure.

ALL FUEL BOOST PUMP
ALL ENGINE START PUMP
ALL IGNITION

4. Application Of Power

NOTE: The following circuit breakers should remain closed for the duration of the test, unless specifically instructed otherwise.

AUTOTHROTTLE
GO AROUND - 1
AUTOTHROTTLE OFF WARNING LIGHTS
GO AROUND - 2
FIRST OFFICER'S HORIZON DISPLAY
FIRST OFFICER'S VERTICAL GYRO
GROUND SPOILER CONTROL
ANTI-SKID SYSTEM CONTROL

NOTE: During this test, the VERTICAL GYRO switch should be placed to NORM. (Autothrottle takes its input signal from No. 2 gyro.)

A. Test Autothrottle Control System

NOTE: The elevator trailing edge should be at neutral position (10 ±3/16 inches below the marked rivet on the left side of the tail cone) before performing the following procedures. The neutral position is obtained with the horizontal stabilizer at zero degrees and the GUST LOCK in the LOCKED position.

(1) Set AIRSPEED ERROR SELECTOR SWITCH (if installed) to CAPT AIS.

(2) Connect Pitot/Static Simulator to Captain's and First Officer's pitot tubes and static ports.

(3) Slowly adjust pitot and static pressure to obtain 160 ±5 knots indication on Captain's Airspeed Indicator.

CAUTION: ALWAYS MAINTAIN PITOT PRESSURE HIGHER THAN STATIC PRESSURE. DO NOT EXCEED MAXIMUM INDICATION OF AIRSPEED INDICATOR TO ELIMINATE POSSIBLE DAMAGE TO TEST EQUIPMENT.

(4) Set reference index on Captain's and First Officer's Airspeed Indicators to coincide with indicated airspeed.

NOTE: If the THROTTLE lights on the instrument failure warning annunciators are on, press Captain's or First Officer's RESET ANNUN switch. Lights should go off.

(5) Move AUTOTHROT engage lever to ENGAGE. Lever should hold.

(6) Move all throttle levers to forward stop. AUTOTHROT lever should hold.

(7) Press DISENGAGE switch located on the outside of No. 1 throttle lever.

(8) The AUTOTHROT lever should move to DISENGAGE. The THROTTLE lights on both the Captain's and the First Officer's NAV INSTR FAILURE WARNING ANNUNCIATOR should come on.

(9) Press Captain's RESET ANNUN switch. Lights should go off.

(10) Move AUTOTHROT lever to ENGAGE.

(11) Press DISENGAGE switch located on the outboard side of No. 4 throttle lever. AUTOTHROT lever should move to DISENGAGE and THROTTLE lights should come on.

(12) Press First Officer's RESET ANNUN switch. Throttle lights should go off.

(13) Move AUTOTHROT lever to ENGAGE.

(14) Move No. 2 throttle lever to aft stop, and slowly move No. 2 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, AUTOTHROT lever should move to DISENGAGE, and THROTTLE lights should come on.

(15) Move No. 2 throttle lever toward forward thrust range.

(16) Move AUTOTHROT lever to ENGAGE. THROTTLE lights should go off.

NOTE: For the remainder of the test procedure, whenever the AUTOTHROT lever is in the ENGAGE position, the THROTTLE lights in both the Captain's and the First Officer's NAV INSTR FAILURE WARNING ANNUNCIATOR(S) should be off. Whenever the AUTOTHROT levers move to the DISENGAGE position, the throttle lights should come on. Ignor these conditions.

(17) Move No. 3 throttle lever to the aft stop, and slowly move No. 3 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, AUTOTHROT lever should move to DISENGAGE and THROTTLE lights should come on.

(18) Move No. 3 Throttle lever to forward thrust range.

(19) Move AUTOTHROT lever to ENGAGE. THROTTLE lights should go off.

(20) Open VERTICAL GYRO -2 circuit breaker. (Supplies monitor signal to Computer/Amplifier.) AUTOTHROT lever should move to DISENGAGE.

(21) Close VERTICAL GYRO -2 circuit breaker, and move AUTOTHROT lever to ENGAGE.

(22) Press GO AROUND switch located on No. 2 throttle lever. AUTOTHROT lever should move to DISENGAGE.

B. ANTI-SKID AUTOTHROTTLE Interlock

(1) Move AUTOTHROT lever to ENGAGE

(2) Open GROUND SPOILER-CONTROL and ANTI-SKID SYSTEM CONTROL circuit breakers.

(3) Remove Anti-Skid Control located in the Accessory Compartment; Sta. 640.

(4) On plug P1-1200 of Anti-Skid Control Rack, jumper pin 32 to pin 12.

(5) Close ANTI-SKID SYSTEM CONTROL and GROUND SPOILER CONTROL circuit breakers.

NOTE: Normal electrical power to various systems will be interrupted when the nose wheel scissor switch torque arm is moved to simulate a nose wheel extended condition. Make certain that essential services are not interrupted. Make certain that all switches and controls of affected systems are in correct position to prevent inadvertent operation of equipment when returning to nose wheel compressed condition.

(6) Remove pin from nose wheel scissor switch torque arm and move torque arm to simulate a nose wheel extended condition.

(7) The AUTOTHROT lever should move to DISENGAGE.

(8) Move the nose wheel scissor switch torque arm to simulate a nose wheel compressed condition.

(9) Open the ANTI-SKID SYSTEM CONTROL and GROUND SPOILER CONTROL circuit breakers.

(10) Remove jumper from between pins 32 and 12 on plug P1-1200 of the Anti-Skid control rack.

(11) On plug P1-1200 of the Anti-Skid control rack jumper pin 32 to pin 29.

(12) Repeat steps (5) through (9).

(13) Remove jumper from between pins 32 and 29 on plug P1-1200 of the Anti-Skid control rack.

(14) Replace Anti-Skid Control Unit.

(15) Return ANTI-SKID CONTROL system and GROUND SPOILER CONTROL system circuit breakers to their original position.

C. Computer/Amplifier - Self Test

(1) Assure that self-test meter on Computer/Amplifier indicates 30 vdc.

(2) Move all throttle levers to mid-position.

(3) Place self-test selector switch on computer/amplifier to position 1. Meter indication should be below the yellow range. (Acceleration input signal check.)

(4) Press and hold computer/amplifier PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(5) Place self-test selector switch in position 2. Meter indication should be below the yellow range. (Airspeed processor check.)

(6) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(7) Place self-test selector switch in position 3. Meter indication should be below the yellow range. (Complimentary filter, synchronization loop, and tachometer check.)

(8) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(9) Place self-test selector switch in position 4. Meter indication should be below the yellow range. (Monitor, level detector, and transformer/rectifier check.)

(10) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

NOTE: When self-test switch is moved to position 5, unless the airspeed error signal is exactly zero, the meter needle should slowly creep toward peg. Pressing the PRESS TO TEST switch will cause the needle to return to the yellow range or below.

(11) Place self-test switch in position 5. Press and hold PRESS TO TEST switch. Meter indication should be in the yellow range. (Amplifier limiter and monitor output check.) Move AUTOTHROT engage lever to ENGAGE. All throttle levers should move aft and meter should remain in the yellow range. Release PRESS TO TEST switch. Throttles should stop moving.

(12) Place self-test selector switch to OFF. Move all throttle levers to aft stop, and move AUTOTHROT engage lever to DISENGAGE.

D. Airspeed Control Error Output

NOTE: If AIRSPEED ERROR SELECTOR SWITCH is installed, for this test select the Captain's Airspeed Indicator as the command indicator. The throttle levers should be operated in range of from 1.25 inches to 3.5 inches. If noted switch is not installed, test will be completed using Captain's AIS.

(1) Move AUTOTHROT lever to ENGAGE, and verify that indicated airspeed is holding at 160 ±5 knots.

(2) Move the reference index on the Captain's Airspeed Indicator to 180 ±5 knots. The throttle levers should move forward.

(3) Move the reference index to 140 ±5 knots. The throttle levers should move aft.

NOTE: If AIRSPEED ERROR SELECTOR SWITCH is installed, repeat steps (2) and (3) using First Officers Airspeed Indicator.

(4) Move reference index to coincide with indicated airspeed.

(5) Move GUST LOCK lever to LOCKED position.

(6) Manually move control column to command full nose up attitude. Throttle levers should move forward.

(7) Manually move control column to command full nose-down attitude. Throttle levers should move aft.

(8) Move control column to neutral and move AUTOTHROT lever to DISENGAGE.

(9) Move GUST LOCK lever to UNLOCKED position.

E. Servo Authority Limit Test

(1) Varify indicated airspeed is maintained at 160 ±5 knots; move all throttle levers to forward stop, and move AUTOTHROT lever to ENGAGE.

(2) Move reference index on Captain's Airspeed Indicator to 120 ±5 knots. All throttle levers should move aft and stop 1 ±1/2 inches forward of aft stop.

NOTE: If all throttle levers do not move from identical positions, discrepancies in lever position will exist when aft motion stops.

(3) Move No. 1 throttle lever to 2 1/2 inches forward of aft stop. Remaining levers should move to aft stop. No. 1 throttle lever should move to 1 inch forward of aft stop.

(4) Move AUTOTHROT lever to DISENGAGE.

(5) Repeat steps (3) and (4) using No. 4 Throttle lever in place of No. 1.

(6) Move reference index on Captain's Airspeed Indicator to 190 ±5 knots and move all throttle levers to aft mechanical stop.

(7) Move AUTOTHROT lever to ENGAGE. All throttle levers should move forward and stop 3 3/4 inches from aft stop.

(8) Move No. 2 throttle lever to aft stop. Remaining throttle levers should hold position.

(9) Align No. 2 throttle levers with remaining throttle levers, move all throttle levers to aft stop, and move AUTOTHROT lever to DISENGAGE.

F. Overpower Test

(1) Move AUTOTHROT lever to ENGAGE.

(2) Move all throttle levers to forward mechanical stop.

(3) Move reference index on Captain's Airspeed Indicator to 140 ±5 knots, after assuring that the indicated airspeed is holding at 160 ±5 knots. Throttle levers should move aft.

(4) It should be possible to manually prevent the aft motion of the throttle levers by holding the levers.

(5) Move all throttle levers to aft stop, and move AUTOTHROT lever to DISENGAGE.

G. Test Termination

(1) Open all circuit breakers that were closed at the beginning of the tests.

(2) Disconnect and remove all test equipment, assuring that all aircraft pitot and static lines are connected or capped.

AUTO THROTTLE - MAINTENANCE PRACTICES

1. General

A. The auto throttle control system tests consist of an operational and a functional test.

B. The operational test determines acceptable operation of the engage/disengage interlocks and the output of the auto throttle computer/amplifier.

C. The functional test should be performed after extensive overhaul of the auto throttle control system or when a system malfunction is suspected.

D. The speed command system associated with the auto throttle control system should be previously checked out and functioning properly before performing auto throttle system tests.

2. Tools and Equipment Required

NOTE: Equivalent substitutes may be used instead of the following listed items.

Item	Name	Number	Manufacturer	Use
A	Mach Calibrator or Air Data Calibrator	2024 VTP-108	Burton Manufacturing Company Intercontinental Dynamics Corp.	Supply airspeed reference to Mach/airspeed indicators when performing functional test.
B	Ruler or measuring tape			Measure throttle lever movement along curved surface or pilot's control pedestal (see Figure 201).

3. Adjustment/Test Auto Throttle Control System (Operational)

A. Test Auto Throttle Control System

NOTE: The throttle systems should be rigged and in working order and the elevator trailing edge at neutral position (10 ± 3/16 inches below marked rivet on left side of tail cone) before performing the following procedures.

(1) Depressurize hydraulic power system (see Chapter 29).

(2) Open following circuit breakers located on EPC circuit breaker panel:

(a) All fuel boost pump circuit breakers.

(b) All engine start pump circuit breakers.

(c) All engine ignition circuit breakers.

<u>NOTE</u>: Steps (3 through 31) test the engage interlocks.

(3) Set index bug of all EPR (engine pressure ratio) indicators to obtain reading of 1.40.

(4) Set reference index on speed command indicator to coincide with indicated airspeed.

(5) Move all throttle levers to forward stop.

(6) If throttle lights on instrument failure warning annunciator are on, press captain's or first officer's instrument warning reset button. Throttle lights should go off.

(7) Move auto throttle lever to engage position. Lever should hold.

(8) Move all throttle levers to aft stop, then to forward stop. Auto throttle lever should hold in engage position.

(9) Press disengage switch located on outboard side of No. 1 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

(10) Press captain's instrument warning reset button. Throttle lights should go off.

(11) Move auto throttle lever to engage position. Lever should hold.

(12) Press disengage switch located on outboard side of No. 4 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

(13) Press first officer's instrument warning reset button. Throttle lights should go off.

(14) Move auto throttle lever to engage position. Lever should hold.

(15) Move No. 2 throttle lever to aft stop and slowly move reverse thrust lever toward reverse thrust. Before reverse thrust lever reaches its mechanical stop, auto throttle lever should move to disengage position and throttle lights should come on.

(16) Move No. 2 throttle lever to forward stop.

(17) Move auto throttle lever to engage position. Lever should hold and throttle lights should go off.

(18) Move No. 3 throttle lever to aft stop and slowly move reverse thrust lever toward reverse thrust. Before reverse thrust lever reaches its mechanical stop, auto throttle lever should move to disengage position and throttle lights should come on.

(19) Move No. 3 throttle lever to forward stop.

(20) Move auto throttle lever to engage position. Lever should hold and throttle lights should go off.

(21) Open first officer's circuit breaker located on EPC circuit breaker panel. Auto throttle lever should move to disengage position and throttle lights should come on.

(22) Close first officer's horizon circuit breaker.

(23) Move auto throttle lever to engage position. Lever should hold and throttle lights should go off.

(24) Press go-around switch located on No. 2 throttle lever. Auto throttle lever should move to disengage position and throttle lights should come on.

(25) Move auto throttle lever to engage position.

(26) Open air data computer circuit breaker. Auto throttle lever should move to disengage position.

(27) Close air data computer circuit breaker.

(28) Move auto throttle lever to engage position. Lever should hold.

(29) Open auto throttle computer circuit breaker. Auto throttle lever should move to disengage position.

(30) Close auto throttle computer circuit breaker.

(31) Move all throttle levers to mid-position.

NOTE: Steps (32 through 40) test the self-test capability of the auto throttle computer.

(32) Check that self-test meter on auto throttle computer located in flight compartment radio rack, indicates 30 vdc (red range).

(33) Place self-test selector switch on computer in position 1. Meter indication should be below yellow range.

(34) Press and hold computer press-to-test switch. Within 20 seconds, meter indication should be in yellow range. Release press-to-test switch.

(35) Place self-test switch in position 2. Meter indication should be below yellow range.

(36) Press and hold press-to-test switch. Within 20 seconds, meter indication should be in yellow range. Release press-to-test switch.

(37) Place self-test switch in position 3. Meter indication should be below yellow range.

(38) Press and hold press-to-test switch. Within 20 seconds, meter indication should be in yellow range. Release press-to-test switch.

(39) Place self-test switch in position 4. Within 20 seconds, meter indication should be below yellow range.

(40) Press and hold press-to-test switch Within 20 seconds, meter indication should be in yellow range. Release press-to-test switch.

(41) Deleted

(42) Deleted

(43) Move all throttle levers to forward stops.

(44) Place self-test switch in position 5. Meter indication should be below yellow range.

(45) Move auto throttle lever to engage position. Lever should hold and throttle lights should go off.

(46) Press and hold press-to-test switch. All throttle levers should move aft and meter indication should be in yellow range. Release press-to-test switch.

NOTE: Meter indication should be observed when throttle levers are moving.

(47) Move auto throttle lever to disengage position. Throttle lights should come on.

(48) Place self-test switch in off position.

(49) Move all throttle levers to aft stops.

NOTE: Steps (50 through 65) test the servo authority limits and the airspeed control error output.

(50) Move reference index on speed command indicator counterclockwise and set at 400 knots.

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(51) Move auto throttle lever to engage position. Lever should hold.

(52) Move No. 1 throttle lever to approximately 2-19/32 inches forward of aft stop. When released, throttle lever should move aft and stop at minimum authority limit position (1 (± 29/64) inch forward of aft stop) (see Figure 201).

(53) Move No. 1 throttle lever to aft stop.

(54) Move No. 4 throttle lever to approximately 2-19/32 inches forward of aft stop. When released, throttle lever should move aft and stop at minimum authority limit position.

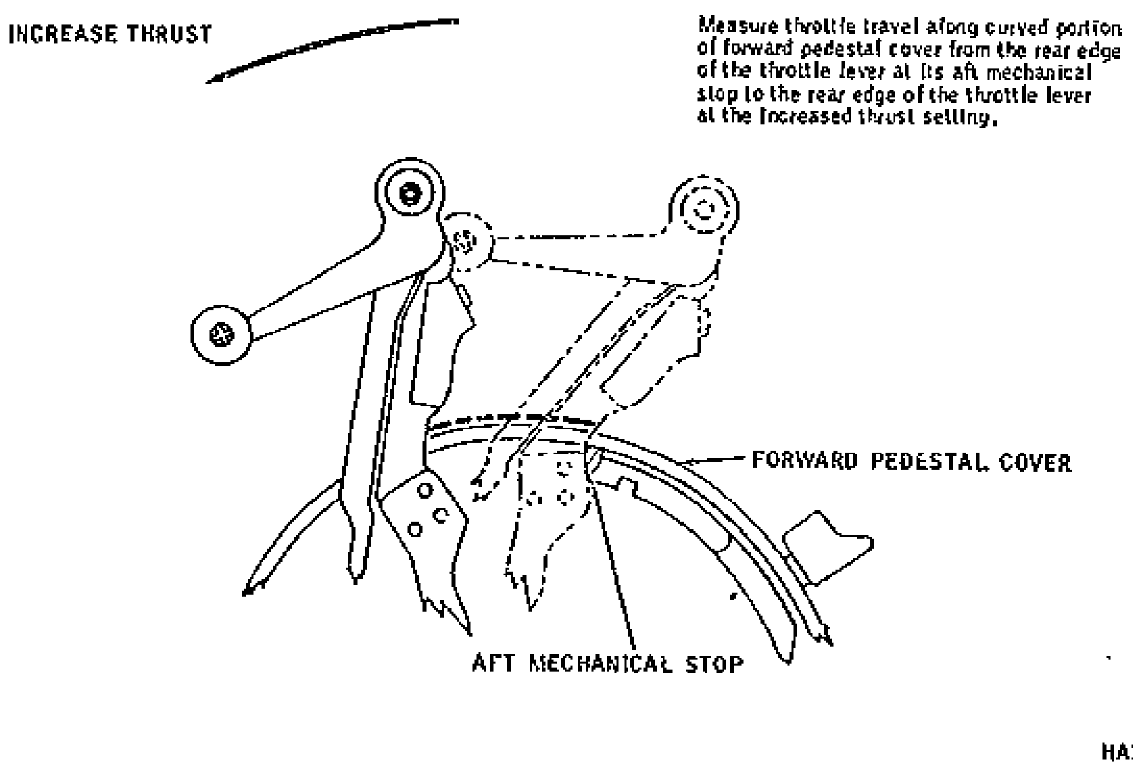
(55) Move No. 4 throttle lever to aft stop.

(56) Move auto throttle lever to disengage position.

(57) Move reference index on speed command indicator clockwise and set at 100 knots.

(58) While holding all throttle levers at aft stops, move auto throttle lever to engage position.

(59) Release No. 1 throttle lever. Lever should move forward.



Measurement Guide -- Throttle Lever Travel
Figure 201

(60) While throttle lever is moving forward, move index bug on No. 1 EPR indicator toward EPR pointer. When index bug reaches EPR reading of 1.10 (± 0.05) No. 1 throttle lever should stop.

NOTE: If the throttle lever contacts the forward stop before completing step (60), move throttle lever to aft stop and release.

(61) Set index bug of No. 1 EPR indicator at 1.40.

(62) Repeat steps (59 through 61) for No. 2, 3, and 4 throttle levers, and using corresponding EPR indicator.

(63) Move auto throttle lever to disengage position. Throttle lights should come on.

(64) Press captain's or first officer's instrument warning reset switch. Throttle lights should go off.

(65) Move all throttle levers to aft stop.

(66) Close following circuit breakers located on EPC circuit breaker panel:

(a) All fuel boost pump circuit breakers.

(b) All engine start pump circuit breakers.

(c) All engine ignition circuit breakers.

4. Adjustment/Test Auto Throttle Control System (Functional)

A. Test Auto Throttle Control System

NOTE: The throttle systems should be rigged and in working order and the elevator trailing edge at neutral position (10 ± 3/16 inches below marked rivet on left side of tail cone) before performing the following procedures.

(1) Depressurizie hydraulic power system (see Chapter 29).

(2) Open following circuit breakers located on EPC circuit breaker panel:

(a) All fuel boost pump circuit breakers.

(b) All engine start pump circuit breakers.

(c) All engine ignition circuit breakers.

(d) Speed command computer circuit breaker.

NOTE: Steps (3 through 41) test the engage interlocks.

(3) Remove speed command computer located in accessory compartment.

(4) Connect jumper between pins 45 and 46 of speed command computer top electrical connector.

(5) Connect jumper between pins 4 and 30 and pins 45 and 46 of bottom electrical connector

(6) Set index bug of all EPR indicators to obtain reading of 1.40.

(7) Close speed command computer circuit breaker.

(8) If throttle lights on failure warning annunciators are on, press captain's or first officer's instrument warning reset button. Lights should go off.

(9) With all throttle levers in approximate midrange position, move auto throttle lever to engage position. Lever should hold; throttles should not move.

(10) Manually move all throttle levers through entire range from aft stop to forward stop. Auto throttle lever should hold in engage position.

(11) Press auto throttle disengage button on left side of No. 1 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

(12) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(13) Press auto throttle disengage button on right side of No. 4 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

(14) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(15) Move No. 2 throttle lever to aft stop and slowly move reverse thrust lever toward reverse thrust. Before reverse thrust lever is 5-1/4 (± 1/16) inches above pedestal cover, auto throttle lever should move to disengage position and throttle lights should come on.

(16) Move No. 2 throttle lever to forward stop.

(17) Move auto throttle lever to engage position. Lever should hold.

(18) Move No. 3 throttle lever to aft stop and slowly move reverse thrust lever toward reverse thrust. Before reverse thrust lever is 5-1/4 (± 1/16) inches above pedestal cover, auto throttle lever should move to disengage position and throttle lights should come on.

(19) Move No. 3 throttle lever to forward stop.

(20) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(21) Open first officer's horizon indicator circuit breaker. Auto throttle lever should move to disengage position.

(22) Close first officer's horizon indicator circuit breaker.

(23) Move auto throttle lever to engage position.

(24) Press go-around switch located on No. 2 throttle lever. Auto throttle lever should move to disengage position; throttle lights should come on.

NOTE: Steps (25 through 41) test the antiskid-auto throttle interlock.

(25) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(26) Open ground spoiler control (ac bus) and anti-skid system control (dc bus) circuit breakers located on EPC circuit breaker panel.

(27) Remove anti-skid control box located in accessory compartment.

(28) Install jumper between pins 12 and 32 of electrical connector.

(29) Close anti-skid system control circuit breaker.

(30) Open both ground control relay circuit breakers located on EPC circuit breaker panel. Auto throttle lever should move to disengage position.

WARNING: NORMAL ELECTRICAL POWER SUPPLY TO VARIOUS SYSTEMS WILL BE INTERRUPTED WHEN GROUND CONTROL RELAY CIRCUIT BREAKERS ARE OPENED. MAKE CERTAIN THAT SWITCHES AND CONTROLS OF AFFECTED SYSTEMS ARE IN CORRECT POSITIONS TO PREVENT INADVERTENT OPERATION OR SHUTDOWN OF EQUIPMENT.

(31) Close both ground control relay circuit breakers.

(32) Open anti-skid system control circuit breaker.

(33) Remove jumper from anti-skid control box electrical connector and install jumper between pins 29 and 32.

(34) Close anti-skid system control circuit breaker. Move auto throttle lever to engage position.

(35) Open both ground control relay circuit breakers. Auto throttle lever should move to disengage position.

(36) Close both ground control relay circuit breakers.

(37) Deleted

(38) Open anti-skid system control circuit breaker.

(39) Remove jumper from anti-skid control box electrical connector.

(40) Install anti-skid control box.

(41) Close ground spoiler control and anti-skid system control circuit breakers.

<u>NOTE</u>: Steps (42 through 63) test the self-test capability of the auto throttle computer.

(42) Check that self-test meter on auto throttle computer located in flight compartment radio rack, indicated 30 vdc.

(42A) Move all throttle levers to mid position.

(43) Place self-test selector switch on computer in position 1. Meter indication should be below yellow range.

(44) Press and hold computer press-to-test switch. Within 20 seconds, meter indication should be in yellow range. Release press-to-test switch.

(45) Place self-test selector switch in position 2. Meter indication should be below yellow range.

(46) Press and hold press-to-test switch. Within 20 seconds, meter indication should be in yellow range. Release press-to-test switch.

(47) Place self-test selector switch in position 3. Meter indication should be below yellow range.

(48) Press and hold press-to-test switch. Within 20 seconds, meter indication should be in yellow range. Release press-to-test switch.

(49) Deleted

(50) Place self-test selector switch in position 4. Within 20 seconds, meter indication should be below yellow range.

(51) Press and hold press-to-test switch. Meter indication should be in yellow range within 20 seconds. Release press-to-test switch.

(52 through 54) Deleted

(55) Place self-test selector switch in position 5. Meter indication should be below yellow range.

(56) Move auto throttle lever to engage position. Lever should hold; throttle lights should go off.

(57) Press and hold press-to-test switch. All throttle levers should move aft; meter indication should be in yellow range. Release press-to-test switch.

NOTE: Meter indication should be observed when throttle levers are moving.

(58) Place self-test selector switch in off position.

(59) Move all throttle levers to aft stop.

(60) Open speed command and auto throttle computer circuit breakers. Auto throttle lever should move to disengage position.

(61) Remove jumpers from top and bottom electrical connectors of speed command computer.

(62) Install speed command computer.

(63) Close speed command and auto throttle computer circuit breakers.

NOTE: Steps (64 through 74) test the airspeed control error and the elevator position sensor outputs. The throttle levers are to be operated within the range of 1-1/4 inches forward of the aft stops to the forward stops.

(64) Set reference index on speed command indicator to coincide with indicated airspeed.

(65) Move auto throttle lever to engage position. Throttle levers should not move.

(66) Move reference index on speed command indicator clockwise and set at 100 knots. Throttle levers should move forward.

(67) Move reference index on speed command indicator counterclockwise and set at 400 knots. Throttle levers should move aft.

(68) Set reference index to coincide with indicated airspeed.

(69) Move gust lock control lever to unlock position.

(70) Manually move elevator trailing edge up. Throttle levers should move forward.

(71) Manually move elevator trailing edge down. Throttle levers should move aft.

(72) Move elevator trailing edge to neutral position.

(73) Move gust lock control lever to lock position.

(74) Move throttle levers to aft stops.

NOTE: Steps (75 through 91) test the servo authority limits and the airspeed control error output.

(75) Move auto throttle lever to disengage position.

(76) Move reference index on speed command indicator counterclockwise and set at 400 knots.

(77) Move auto throttle lever to engage position. Lever should hold.

(78) Move No. 1 throttle lever to approximately 2-19/32 inches forward of aft stop. When released, throttle lever should move aft and stop at minimum authority limit position (1 (±29/64) inch forward of aft stop) (see Figure 201).

(79) Move No. 1 throttle lever to aft stop.

(80) Move No. 4 throttle lever to approximately 2-19/32 inches forward of aft stop. When released, throttle lever should move aft and stop at minimum authority limit position.

(81) Move No. 4 throttle lever to aft stop.

(82) Move auto throttle lever to disengage position.

(83) Move reference index on speed command indicator clockwise and set at 100 knots.

(84) While holding all throttle levers at aft stops, move auto throttle lever to engage position.

(85) Release No. 1 throttle lever. Lever should move forward.

(86) While throttle lever is moving forward, move index bug on No. 1 EPR indicator toward EPR pointer. When index bug reaches EPR reading of 1.10 (± 0.05) No. 1 throttle lever should stop.

NOTE: If the throttle lever contacts the forward stop before completing step (86), move throttle lever to aft stop and release.

(87) Set index bug of No. 1 EPR indicator at 1.40.

(88) Repeat steps (85 through 87) for No. 2, 3, and 4 throttle levers, and using corresponding EPR indicator.

(89) Move auto throttle lever to disengage position. Throttle lights should come on.

(90) Press captain's or first officer's instrument warning reset switch. Throttle lights should go off.

(91) Move all throttle levers to aft stop.

(92) Close following circuit breakers located on EPC circuit breaker panel:

(a) All fuel boost pump circuit breakers.

(b) All engine start pump circuit breakers.

(c) All engine ignition circuit breakers.

AUTOTHROTTLE - MAINTENANCE PRACTICES

1. General

   A. This section contains a series of cockpit functional tests.

   B. Should any of these tests fail, refer to the applicable trouble shooting section for corrective action.

2. Tools and Equipment Required

   NOTE: Suitable substitutes may be used in lieu of the following listed items.

Item	Name	Number	Manufacturer	Use
A	Simulator, Pitot & Static	VTP-10-12762	Intercontinental Dynamics Corp.	To supply air speed reference to the air-speed indicator.
B	Measuring tape, or flexible rule.			Measure throttle lever movement along curved surface of control pedestal.

3. Preliminary Test Requirements

   A. Rigging of fuel control system and engine throttles should be complete and in working order.

   B. The airspeed control system associated with the Autothrottle System should be checked out previously and in working order.

   C. Remove hydraulic power from airplane.

   D. Open the following circuit breakers and have them remain open throughout this test procedure.

      ALL FUEL BOOST PUMP
      ALL ENGINE START PUMP
      ALL IGNITION

4. Application of Power

NOTE: The following circuit breakers should remain closed for the duration of the test, unless specifically instructed otherwise.

AUTOTHROTTLE
GO AROUND - 1
AUTOTHROTTLE OFF WARNING LIGHTS
GO AROUND - 2
CAPTAIN'S HORIZON DISPLAY
CAPTAIN'S VERTICAL GYRO
GROUND SPOILER CONTROL
ANTI-SKID SYSTEM CONTROL

NOTE: During this test, the vertical gyro switch should be placed in normal position. (Autothrottle takes its input signal from No. 1 gyro.)

A. Test Autothrottle Control System

NOTE: The elevator trailing edge should be at neutral position (10 ±3/16 inches below the marked rivet on the left side of the tail cone) before performing the following procedures. The neutral position is obtained with the horizontal stabilizer at zero degrees. The following tests can be performed using the captain's and first officer's airspeed errors if an airspeed error selector switch is installed. If an airspeed error selector switch is not installed, the tests will be performed using the captain's mach/airspeed indicator; and all reference to first officer's mach/airspeed indicator and pitot-static system should be disregarded.

(1) Set airspeed error selector switch (if installed) to captain IAS.

(2) Connect pitot/static simulator to captain's and first officer's pitot tubes and static ports.

(3) Slowly adjust pitot and static pressure to obtain 160 ±5 knots indication on captain's airspeed indicator.

CAUTION: ALWAYS MAINTAIN PITOT PRESSURE HIGHER THAN STATIC PRESSURE. DO NOT EXCEED MAXIMUM INDICATION OF AIRSPEED INDICATOR TO ELIMINATE POSSIBLE DAMAGE TO TEST EQUIPMENT.

(4) Set reference index on captain's and first officer's airspeed indicators to coincide with indicated airspeed.

NOTE: If the throttle lights on the instrument failure warning annunciators are on, press captain's or first officer's monitor reset switch. Lights should go off.

(5) Move autothrottle engage lever to engage. Lever should hold.

(6) Move all throttle levers through their entire range. Autothrottle lever should hold.

(7) Press disengage switch located on the outside of No. 1 throttle lever.

(8) The autothrottle lever should move to disengage. The throttle lights on both the captain's and the first officer's navigation instrument failure warning annunciator should come on.

(9) Press captain's monitor reset switch. Lights should go off.

(10) Move autothrottle lever to engage.

(11) Press disengage switch located on the outboard side of No. 4 throttle lever. Autothrottle lever should move to disengage and throttle lights should come on.

(12) Press first officer's monitor reset switch. Throttle lights should go off.

(13) Move autothrottle lever to engage.

(14) Move No. 2 throttle lever to aft stop, and slowly move No. 2 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, autothrottle lever should move to disengage, and throttle lights should come on.

(15) Move No. 2 throttle lever to forward thrust range.

(16) Move autothrottle lever to engage. Throttle lights should go off.

NOTE: For the remainder of the test procedure, whenever the autothrottle lever is in the engage position, the throttle lights in both the captain's and the first officer's navigation instrument failure warning annunciators should be off. Whenever the autothrottle lever moves to the disengage position, the throttle lights should come on. Ignore these conditions.

(17) Move No. 3 throttle lever to the aft stop, and slowly move No. 3 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, autothrottle lever should move to disengage and throttle lights should come on.

(18) Move No. 3 throttle lever to forward thrust range.

(19) Move autothrottle lever to engage. Throttle lights should go off.

(20) Open vertical gyro-1 circuit breaker. (Supplies monitor signal to computer/amplifier.) Autothrottle lever should move to disengage.

(21) Close vertical gyro-1 circuit breaker, and move autothrottle lever to ENGAGE.

(22) Press go around switch located on No. 2 throttle lever. Autothrottle lever should move to disengage.

B. ANTI-SKID AUTOTHROTTLE Interlock

(1) Mark II Anti-Skid System (if installed) see Figure 201.

(a) Move autothrottle lever to engage.

(b) Open ground spoiler-control and anti-skid system control circuit breakers.

(c) Remove anti-skid control located in the accessory Compartment; Sta. 640.

(d) On plug P1-1200 of anti-skid control rack, jumper pin 32 to pin 12.

(e) Close ANTI-SKID SYSTEM CONTROL and GROUND SPOILER CONTROL circuit breakers.

NOTE: Normal electrical power to various systems will be interrupted when the nose wheel scissor switch torque arm is moved to simulate a nose wheel extended condition. Make certain that essential services are not interrupted. Make certain that all switches and controls of affected systems are in correct position to prevent inadvertent operation of equipment when returning to nose wheel compressed condition.

(f) Remove pin from nose wheel scissor switch torque arm and move torque arm to simulate a nose wheel extended condition.

(g) The autothrottle lever should move to disengage.

(h) Move the nose wheel scissor switch torque arm to simulate a nose wheel compressed condition.

(i) Open the anti-skid system control and ground spoiler control circuit breakers.

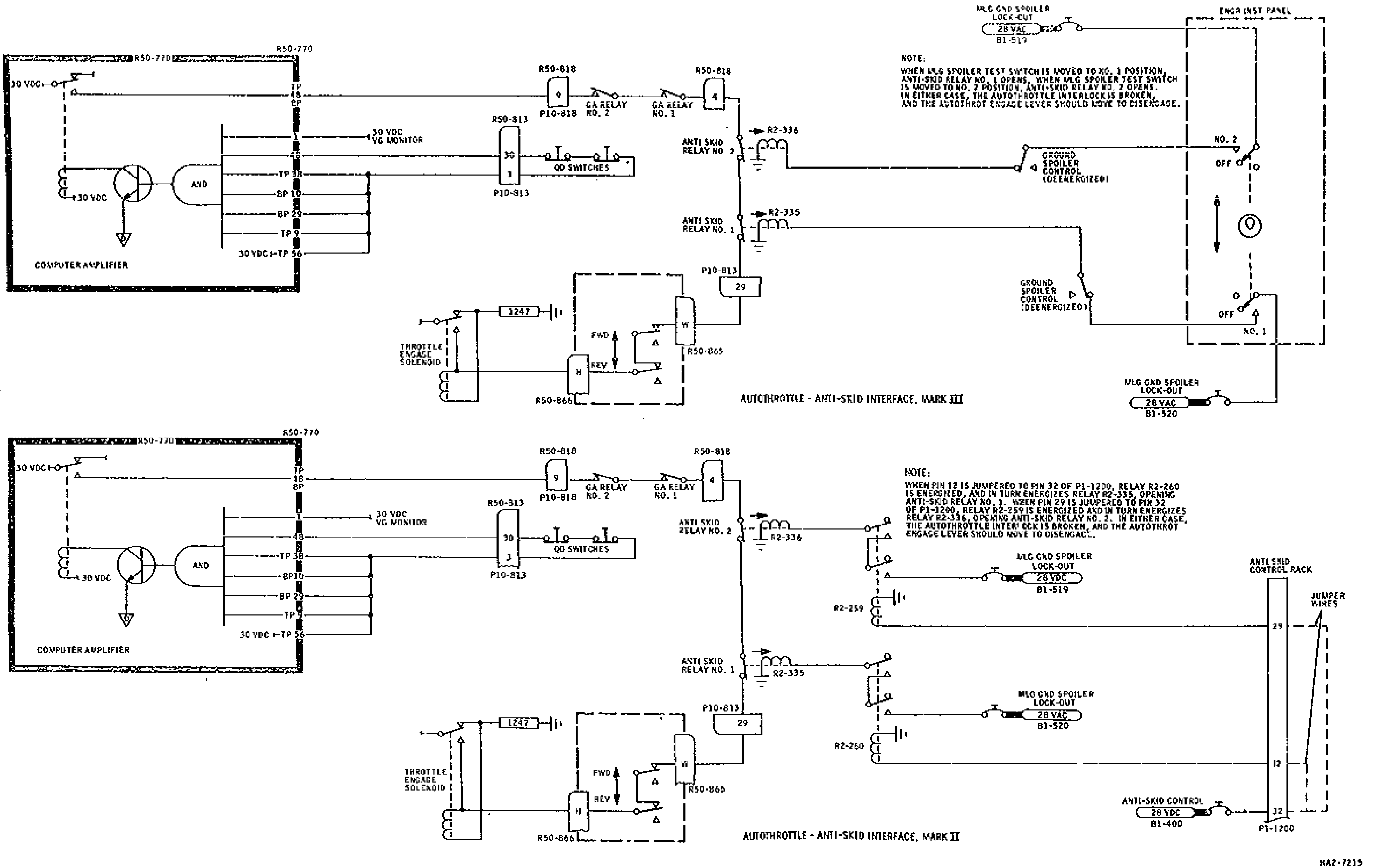
(j) Remove jumper from between pins 32 and 12 on plug P1-1200 of the anti-skid control rack.

(k) On plug P1-1200 of the anti-skid control rack jumper pin 32 to pin 29.

(l) Close the anti-skid system and ground spoiler control circuit breakers.

(m) Move the autothrottle lever to engage position.

(n) Move the nose wheel scissor switch torque arm to simulate a nose wheel extended condition.



Autothrottle Antiskid Interface
Figure 201

(o) The autothrottle lever should move to disengage position.

(p) Return nose wheel scissor switch torque arm to its original position and replace pin.

(q) Open the anti-skid and ground spoiler control circuit breakers.

(r) Remove jumper from between pins 32 and 29 on plug P1-1200 of the anti-skid control rack.

(s) Replace anti-skid control unit.

(t) Return anti-skid control system and ground spoiler control system circuit breakers to their original position.

(2) Mark III Antiskid System (if applicable) see Figure 201

(a) Close the spoiler lockout circuit breakers.

(b) Move the autothrottle lever to engage position.

(c) Move the flight engineer's main landing gear spoiler test switch to the No. 1 position.

(d) The autothrottle lever should move to disengage.

(e) Move the autothrottle lever to engage position.

(f) Move the flight engineer's main landing gear spoiler test switch to the No. 2 position.

(g) The autothrottle lever should move to the disengage position.

(h) Open the spoiler lockout circuit breakers.

C. Computer/Amplifier - Self-Test

(1) Assure that self-test meter on computer/amplifier indicates 30 vdc (red range).

(2) Move all throttle levers to mid-position.

(3) Place self-test selector switch on computer/amplifier to position 1. Meter indication should be below the yellow range. (Acceleration input signal check.)

(4) Press and hold computer/amplifier press to test switch. Within 20 seconds meter indication should be in the yellow range. Release press to test switch (accelerometer test).

(5) Place self-test selector switch in position 2. Meter indi ation should be below the yellow range. (Airspeed processor check.)

(6) Press and hold press to test switch. Within 20 seconds meter indication should be in the yellow range. Release press to test switch.

(7) Place self-test selector switch in position 3. Meter indication should be below the yellow range. (Complimentary filter, synchronization loop, and tachometer check.)

(8) Press and hold press to test switch. Within 20 seconds meter indication should be in the yellow range. Release press to test switch.

(9) Place self-test selector switch in position 4. Meter indication should be below the yellow range. (Monitor, level detector, and transformer/rectifier check.)

(10) Press and hold press to test switch. Within 20 seconds meter indication should be in the yellow range. Release press to test switch.

<u>NOTE</u>: When self-test switch is moved to position 5, unless the airspeed error signal is exactly zero, the meter needle should slowly creep toward peg. Pressing the press to test switch will cause the needle to return to the yellow range or below.

(11) Place self-test switch in position 5. Press and hold press to test switch. Meter indication should be in the yellow range. (Amplifier limiter and monitor output check.) Move autothrottle engage lever to engage. All throttle levers should move aft and meter should remain in the yellow range. Release press to test switch. Throttles should stop moving.

(12) Place self-test selector switch to off. Move all throttle levers to aft stop, and move autothrottle engage lever to disengage.

D. Airspeed Control Error Output

<u>NOTE</u>: If airspeed error selector switch is installed, for this test select the captain's airspeed indicator as the command indicator. The throttle levers should be operated in range of from 1.25 inches to 3.5 inches. If noted switch is not installed, test will be completed using captain's airspeed indicator.

(1) Move autothrottle lever to engage, and verify that indicated airspeed is holding at 160 ±5 knots.

(2) Move the reference index on the captain's airspeed indicator to 180 ±5 knots. The throttle levers should move forward.

(3) Move the reference index to 140 ±5 knots. The throttle levers should move aft.

<u>NOTE</u>: If airspeed error selector switch is installed, repeat Steps (2) and (3) using first officer's airspeed indicator.

(4) Move reference index to coincide with indicated airspeed.

(5) Manually move control column to command full nose up attitude. Throttle levers should move forward.

(6) Manually move control column to command full nose-down attitude. Throttle levers should move aft.

(7) Move control column to neutral and move autothrottle lever to disengage.

E. Servo Authority Limit Test

(1) Verify indicated airspeed is maintained at 160 ±5 knots; move all throttle levers to forward stop, and move autothrottle lever to engage.

(2) Move reference index on captain's airspeed indicator to 120 ±5 knots. All throttle levers should move aft and stop 1 ±1/2 inches forward of aft stop.

NOTE: If all throttle levers do not move from identical positions, discrepancies in lever position will exist when aft motion stops.

(3) Move No. 1 throttle lever to 2 1/2 inches forward of aft stop. Remaining levers should move to aft stop. No. 1 throttle lever should move to 1 inch forward of aft stop.

(4) Move autothrottle lever to disengage.

(5) Repeat Steps (3) and (4) using No. 4 throttle lever in place of No. 1.

(6) Move reference index on captain's airspeed indicator to 190 ±5 knots, and move all throttle levers to aft mechanical stop.

(7) Move autothrottle lever to engage. All throttle levers should move forward and stop 3 3/4 inches from aft stop.

(8) Move No. 2 throttle lever to aft stop. Remaining throttle levers should hold position.

(9) Align No. 2 throttle levers with remaining throttle levers, move all throttle levers to aft stop, and move autothrottle lever to disengage.

F. Overpower Test

(1) Move autothrottle lever to engage.

(2) Move all throttle levers to forward mechanical stop.

(3) Move reference index on captain's airspeed indicator to 140 ±5 knots, after assuring that the indicated airspeed is holding at 160 ±5 knots. Throttle levers should move aft.

(4) It should be possible to manually prevent the aft motion of the throttle levers by holding the levers.

(5) Move all throttle levers to aft stop, and move autothrottle lever to disengage.

G. Test Termination

(1) Open all circuit breakers that were closed at the beginning of the tests.

(2) Disconnect and remove all test equipment, assuring that all aircraft pitot and static lines are connected or capped.

AUTOTHROTTLE - MAINTENANCE PRACTICES

1. General

   A. This section contains a series of cockpit functional tests.

   B. Should any of these tests fail, refer to the applicable trouble shooting section for corrective action.

2. Tools and Equipment Required

Item	Name	Number	Manufacturer	Use
A	Simulator, pitot & static pressure	VPT-10C	International Dynamics Corp.	So supply airspeed reference to the airspeed indicator.
B	Tape, measuring, or rule, flexible			To measure throttle lever movement along the curved surface of the pedestal.

3. Preliminary Test Requirements

   A. Rigging of fuel control system and engine throttles should be complete and in working order.

   B. The airspeed control system associated with the autothrottle system should be checked out previously and in working order.

   C. Remove hydraulic power from aircraft.

   D. Open the following circuit breakers and have them remain open throughout this test procedure:

Circuit Breaker	Location
All Fuel Boost Pump	AC Busses 1, 2, 3, & 4
Engine Starters	Battery Bus
Ignition PWR Supply	Battery Bus
Ignition PWR Supply Cont	Battery Bus

4. Application of Power

A. Close the following circuit breakers and have them remain closed for the duration of the test unless specifically instructed otherwise:

Circuit Breaker	Location
Autothrottle 115 Vac	Radio Bus 2
Autothrottle Off Warn Lt	Radio Bus 3
Anti-Skid System	DC Busses 1 & 4
Ground Spoiler Control	AC Bus 4
Vertical Gyro 1 (Aircraft N789FT and Subs)	Left AC Emer Bus
Vertical Gyro 2 (Aircraft N779FT thru N788FT)	Right AC Emer Bus
Aux Vertical Gyro	Right & Left AC Emer Busses
Vert Gyro Transfer	Right DC Emer Bus
Horizon Display (Capt's & F.O.)	Right & Left AC Emer Busses
Navigation Inst XFMR 1 & 2	Radio Busses 2 & 3
Go Around 1 & 2	Radio Busses 2 & 3
Radio Bus 2 Load Monitor	Radio Bus 2
Radio Bus 3 Load Monitor	Radio Bus 3

5. Autothrottle Control System

A. For the following test procedure the elevator trailing edge should be at neutral position, (10 ±3/16 inches below the marked rivet on the left side of the tail cone) before performing the tests. The neutral position should be obtained with the horizontal stabilizer at zero degrees and the GUST LOCK in LOCKED position.

(1) Set AIRSPEED ERROR SELECTOR switch to CAPT IAS.

(2) Connect pitot/static simulator to captain's and first officer's pitot tubes and static ports.

(3) Slowly adjust pitot and static pressure to obtain 160 ±5 knots indication on captain's and first officer's airspeed indicators.

CAUTION: ALWAYS MAINTAIN PITOT PRESSURE HIGHER THAN STATIC PRESSURE. DO NOT EXCEED MAXIMUM INDICATION ON AIRSPEED INDICATORS TO AVOID DAMAGE TO INSTRUMENTS.

(4) Set reference index on captain's and first officer's airspeed indicators to coincide with indicated airspeed.

(5) Move AUTOTHROT engage lever to ENGAGE. Lever should hold.

(6) Move all throttle levers to forward stop. AUTOTHROT engage lever should hold.

(7) Press DISENGAGE switch on outboard side of No. 1 throttle lever. AUTOTHROT engage lever should move to DISENGAGE. THROTTLE lights on both captain's and first officer's NAV INSTR FAILURE WARNING ANNUNCIATOR should come on.

(8) Press captain's RESET ANNUN switch. THROTTLE lights should go off.

(9) Move AUTOTHROT lever to ENGAGE.

(10) Press DISENGAGE switch on outboard side of No. 4 throttle lever. AUTOTHROT lever should move to DISENGAGE, and THROTTLE lights should come on.

(11) Press first officer's RESET ANNUN switch. THROTTLE lights should go off.

(12) Move AUTOTHROT lever to ENGAGE.

(13) Move No. 2 throttle lever to aft stop, and slowly move No. 2 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, AUTOTHROT lever should move to DISENGAGE, and THROTTLE lights should come on.

(14) Return No. 2 reverse thrust lever to forward thrust range.

(15) Move AUTOTHROT lever to ENGAGE. THROTTLE lights should go off.

NOTE: For the remainder of the test procedure, whenever the AUTOTHROT engage lever is in the ENGAGE position the THROTTLE lights on both the captain's and the first officer's NAV INSTR FAILURE WARNING ANNUNCIATOR(s) should be off. Whenever the AUTOTHROT engage lever moves to DISENGAGE position, the THROTTLE lights should come on. Disregard these conditions.

(16) Move No. 3 throttle lever to aft stop, and slowly move No. 3 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, AUTOTHROT lever should move to DISENGAGE.

(17) Return No. 3 reverse thrust lever to forward thrust range.

(18) Move AUTOTHROT lever to ENGAGE.

NOTE: On aircraft N779FT thru N788FT, autothrottle receives pitch monitor signals from VERTICAL GYRO 2. On aircraft N789FT and subs autothrottle receives pitch monitor signals from VERTICAL GYRO 1.

(19) Open applicable VERTICAL GYRO circuit breaker. (Supplies monitor signal to Computer/Amplifier.) AUTOTHROT lever should move to DISENGAGE.

(20) Close VERTICAL GYRO circuit breaker and move AUTOTHROT lever to ENGAGE.

(21) Move VERTICAL GYRO switch on overhead switch panel from NORMAL to CAPT ON AUX and repeat steps (19) and (20).

(22) Move AIRSPEED ERROR SELECTOR switch to F.O. IAS, then move VERTICAL GYRO switch to F/O ON AUX and repeat steps (19) and (20).

(23) Press GO AROUND switch on aft side of No. 2 throttle lever. AUTOTHROT lever should move to DISENGAGE.

B. Anti-Skid - Autothrottle Interlock

(1) Move AUTOTHROT engage lever to ENGAGE.

(2) Open GROUND SPOILER CONTROL AND ANTI-SKID SYSTEM circuit breakers.

(3) Remove anti-skid control located in the accessory compartment; sta. 640.

(4) On plug P1-1200 of anti-skid control rack, jumper pin 12 to pin 32.

(5) Close ANTI-SKID SYSTEM CONTROL and GROUND SPOILER CONTROL circuit breakers.

NOTE: Normal electrical power to various systems will be interrupted when the nose wheel scissor switch torque arm is moved to simulate a nose wheel extended condition. Make certain that essential services are not interrupted. Make certain that all switches and controls of affected systems are in correct position to prevent inadvertent operation of equipment when returning to nose wheel compressed condition.

(6) Remove pin from nose wheel scissor switch torque arm and move torque arm to simulate a nose wheel extended condition.

(7) The AUTOTHROT lever should move to DISENGAGE.

(8) Move the nose wheel scissor switch torque arm to simulate a nose wheel compressed condition.

(9) Open the ANTI-SKID SYSTEM CONTROL and GROUND SPOILER CONTROL circuit breakers.

(10) Remove jumper from between pins 32 and 12 on plug P1-1200 of the Anti-Skid control rack.

(11) On plug P1-1200 of the Anti-Skid control rack jumper pin 32 to pin 29.

(12) Repeat Steps (5) through (9).

(13) Remove jumper from between pins 32 and 29 on plug P1-1200 of the Anti-Skid control rack.

(14) Replace Anti-Skid Control Unit.

(15) Return ANTI-SKID CONTROL system and GROUND SPOILER CONTROL system circuit breakers to their original position.

C. Computer/Amplifier - Self-Test

(1) Assure that self-test meter on Computer/Amplifier indicates 30 vdc.

(2) Move all throttle levers to mid-position.

(3) Place self-test selector switch on computer/amplifier to position 1. Meter indication should be below the yellow range. (Acceleration input signal check.)

(4) Press and hold computer/amplifier PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(5) Place self-test selector switch in position 2. Meter indication should be below the yellow range. (Airspeed processor check.)

(6) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(7) Place self-test selector switch in position 3. Meter indication should be below the yellow range. (Complimentary filter, synchronization loop, and tachometer check.)

(8) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(9) Place self-test selector switch in position 4. Meter indication should be below the yellow range. (Monitor, level detector, and transformer rectifier check.)

(10) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

NOTE: When self-test switch is moved to position 5, unless the airspeed error signal is exactly zero, the meter needle may slowly creep toward peg. Pressing the PRESS TO TEST switch will cause the needle to return to the yellow range or below.

(11) Place self-test switch in position 5. Press and hold PRESS TO TEST switch. Meter indication should be in the yellow range. (Amplifier limiter and monitor output check.) Move AUTOTHROT engage lever to ENGAGE. All throttle levers should move aft, and meter indication should remain in the yellow range. Release PRESS TO TEST switch. Throttle levers should stop moving.

(12) Place self-test selector switch to OFF. Move all throttle levers to aft stop, and move AUTOTHROT engage lever to DISENGAGE.

D. Airspeed Control Error Output

NOTE: For this test, select the captain's airspeed indicator as the command indicator. The throttle levers should operate in range from 1.25 inches to 3.5 inches.

(1) Move AUTOTHROT lever to ENGAGE, and verify that indicated airspeed is holding at 160 ±5 knots.

(2) Move reference index in captain's airspeed indicator to 180 ±5 knots. Throttle levers should move forward.

(3) Move the reference index to 140 ±5 knots. The throttle levers should move aft.

NOTE: Repeat steps (2) and (3) selecting F.O. IAS. Return AIRSPEED ERROR SELECTOR switch to CAPT IAS.

(4) Move reference index to coincide with indicated airspeed.

(5) Move GUST LOCK lever to LOCKED position.

(6) Manually move control column to command full nose up attitude. Throttle levers should move forward.

(7) Manually move control column to command full nose-down attitude. Throttle levers should move aft.

(8) Move control column to neutral and move AUTOTHROT lever to DISENGAGE.

(9) Move GUST LOCK lever to UNLOCKED position.

E. Servo Authority Limit Test

(1) Verify indicated airspeed is maintained at 160 ±5 knots; move all throttle levers to forward stop, and move AUTOTHROT lever to ENGAGE.

(2) Move reference index on captain's airspeed indicator to 120 ±5 knots. All throttle levers should move aft and stop 1 ±1/2 inches forward of aft stop.

NOTE: If all throttle levers do not move from identical positions, discrepancies in lever position will exist when aft motion stops.

(3) Move No. 1 throttle lever to 2 1/2 inches forward of aft stop. Remaining levers should move to aft stop. No. 1 throttle lever should move to 1 inch forward of aft stop.

(4) Move AUTOTHROT lever to DISENGAGE.

(5) Repeat Steps (3) and (4) using No. 4 throttle lever in place of No. 1.

(6) Move reference index on captain's airspeed indicator to 190 ±5 knots, and move all throttle levers to aft mechanical stop.

(7) Move AUTOTHROT lever to ENGAGE. All throttle levers should move forward and stop 3 3/4 inches from aft stop.

(8) Move No. 2 throttle lever to aft stop. Remaining throttle levers should hold position.

(9) Align No. 2 throttle levers with remaining throttle levers, move all throttle levers to aft stop, and move AUTOTHROT lever to DISENGAGE.

F. Overpower Test

(1) Move AUTOTHROT lever to ENGAGE.

(2) Move all throttle levers to forward mechanical stop.

(3) Move reference index on captain's airpseed indicator to 140 ±5 knots, after assuring that the indicated airspeed is holding at 160 ±5 knots. Throttle levers should move aft.

(4) It should be possible to manually prevent the aft motion of the throttle levers by holding the levers.

(5) Move all throttle levers to aft stop, and move AUTOTHROT lever to DISENGAGE.

G. Test Termination

(1) Open all circuit breakers that were closed at the beginning of the tests.

(2) Disconnect and remove all test equipment, assuring that all aircraft pitot and static lines are connected or capped.

AUTOTHROTTLE - MAINTENANCE PRACTICES

1. General

   A. This section contains a series of cockpit functional tests.

   B. Should any of these tests fail, refer to the applicable trouble shooting section for corrective action.

2. Tools and Equipment Required

Item	Name	Number	Manufacturer	Use
A	SIMULATOR, Pitot & Static Pressure	VPT-10C	International Dynamics Corp.	So supply airspeed reference to the airspeed indicator.
B	TAPE, Measuring or RULE, Flexible			To measure throttle lever movement along the curved surface of the pedestal.

3. Preliminary Test Requirements

   A. Rigging of fuel control system and engine throttles should be complete and in working order.

   B. The airspeed control system associated with the autothrottle system should be checked out previously and in working order.

   C. Remove hydraulic power from aircraft.

   D. Open the following circuit breakers and have them remain open throughout this test procedure:

Circuit Breaker	Location
All Fuel Boost Pump	AC Busses 1, 2, 3, & 4
Engine Starters	Battery Bus
Ignition PWR Supply	Battery Bus
Ignition PWR Supply Cont	Battery Bus

4. Application of Power

A. Close the following circuit breakers and have them remain closed for the duration of the test unless specifically instructed otherwise:

Circuit Breaker	Location
Autothrottle 115 VAC	Radio Bus 2
Autothrottle Off Warn LT	Radio Bus 3
Anti-Skid System	DC Busses 1 & 4
Ground Spoiler Control	AC Bus 4
Capt's Horizon	Left AC EMER Bus
Navigation INST XFMR 1 & 2	Radio Busses 2 & 3
Flight Director 1 & 2	Radio Busses 2 & 3
Radio Bus 2 Load Monitor	Radio Bus 2
Radio Bus 3 Load Monitor	Radio Bus 3

5. Autothrottle Control System

A. Test Autothrottle Engage Interlocks.

NOTE: For the following test procedure the elevator trailing edge should be at neutral position (10 ± 3/16 inches below the marked rivet on the left side of the tail cone) before performing the tests. The neutral position should be obtained with the horizontal stabilizer at zero degrees, and the GUST LOCK in the LOCKED position.

(1) Set AIRSPEED ERROR SELECTOR switch to CAPT IAS.

(2) Connect pitot/static simulator to captain's and first officer's pitot tubes and static ports.

(3) Slowly adjust pitot and static pressure to obtain 160 ±5 knots indication on captain's and first officer's airspeed indicators.

CAUTION: ALWAYS MAINTAIN PITOT PRESSURE HIGHER THAN STATIC PRESSURE. DO NOT EXCEED MAXIMUM INDICATION OF AIRSPEED INDICATOR TO PREVENT POSSIBLE DAMAGE TO INSTRUMENTS.

(4) Set reference index on captain's and first officer's airspeed indicators to coincide with indicated airspeed.

(5) Move AUTOTHROT lever to ENGAGE. Lever should hold.

(6) Move all throttle levers to forward stop. AUTOTHROT engage lever should hold.

(7) Press DISENGAGE switch located on outboard side of no. 1 throttle lever. AUTOTHROT engage lever should move to DISENGAGE. THROTTLE lights on both captain's and first officer's NAV INSTR FAILURE WARNING ANNUNCIATOR should come on.

(8) Press captain's RESET ANNUN switch. THROTTLE lights should go off.

(9) Move AUTOTHROT lever to ENGAGE.

(10) Press DISENGAGE switch located on outboard side of no. 4 throttle lever. AUTOTHROT lever should move to DISENGAGE and THROTTLE lights should come on.

(11) Press first officer's RESET ANNUN switch. THROTTLE lights should go off.

(12) Move AUTOTHROT lever to ENGAGE.

(13) Move no. 2 throttle lever to aft stop, and slowly move no. 2 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, AUTOTHROT lever should move to DISENGAGE and THROTTLE lights should come on.

(14) Return no. 2 reverse thrust lever to forward thrust range.

(15) Move AUTOTHROT lever to ENGAGE. THROTTLE lights should go off.

NOTE: For the remainder of the test procedure, whenever the AUTOTHROT lever is in ENGAGE position, THROTTLE lights on both the captain's and the first officer's NAV INSTR FAILURE WARNING ANNUNCIATOR (s) should be off. Whenever the AUTOTHROT lever moves to DISENGAGE, the THROTTLE lights should come on. Disregard these conditions.

(16) Move no. 3 throttle lever to the aft stop, and slowly move no. 3 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, AUTOTHROT lever should move to DISENGAGE. THROTTLE lights should come on.

(17) Return no. 3 reverse thrust lever to forward thrust range.

(18) Move AUTOTHROT lever to ENGAGE. THROTTLE lights should go off.

(19) Open CAPT'S HORIZON circuit breaker. (Supplies monitor signal to Computer/Amplifier). AUTOTHROT lever should move to DISENGAGE.

(20) Close CAPT'S HORIZON circuit breaker, and move AUTOTHROT lever to ENGAGE.

(21) Select RADIO AUTO or RADIO MANUAL position on either flight director mode selector switch and press GO-AROUND switch located on no. 2 throttle lever. AUTOTHROT lever should move to DISENGAGE.

B. Anti-Skid -- Autothrottle Interlock

(1) Move AUTOTHROT lever to ENGAGE.

(2) Open GROUND SPOILER CONTROL and ANTI-SKID SYSTEM circuit breakers.

(3) Remove anti-skid control located in the Accessory Compartment; Sta. 640.

(4) On plug P1-1200 of anti-skid control rack, jumper pin 12 to pin 32.

(5) Close ANTI-SKID SYSTEM CONTROL and GROUND SPOILER CONTROL circuit breakers.

NOTE: Normal electrical power to various systems will be interrupted when the nose wheel scissor switch torque arm is moved to simulate a nose wheel extended condition. Make certain that essential services are not interrupted. Make certain that all switches and controls of affected systems are in correct position to prevent inadvertent operation of equipment when returning to nose wheel compressed condition.

(6) Remove pin from nose wheel scissor switch torque arm and move torque arm to simulate a nose wheel extended condition.

(7) The AUTOTHROT lever should move to DISENGAGE.

(8) Move the nose wheel scissor switch torque arm to simulate a nose wheel compressed condition.

(9) Open the ANTI-SKID SYSTEM CONTROL and GROUND SPOILER CONTROL circuit breakers.

(10) Remove jumper from between pins 32 and 12 on plug P1-1200 of the Anti-Skid control rack.

(11) On plug P1-1200 of the Anti-Skid control rack jumper pin 32 to pin 29.

(12) Repeat Steps (5) through (9).

(13) Remove jumper from between pins 32 and 29 on plug P1-1200 of the Anti-Skid control rack.

(14) Replace Anti-Skid Control Unit.

(15) Return ANTI-SKID CONTROL system and GROUND SPOILER CONTROL system circuit breakers to their original position.

C. Computer/Amplifier - Self-Test

(1) Assure that self-test meter on Computer/Amplifier indicates 30 vdc.

(2) Move all throttle levers to mid-position.

(3) Place self-test selector switch on computer/amplifier to position 1. Meter indication should be below the yellow range. (Acceleration input signal check.)

(4) Press and hold computer/amplifier PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(5) Place self-test selector switch in position 2. Meter indication should be below the yellow range. (Airspeed processor check.)

(6) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(7) Place self-test selector switch in position 3. Meter indication should be below the yellow range. (Complimentary filter, synchronization loop, and tachometer check.)

(8) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

(9) Place self-test selector switch in position 4. Meter indication should be below the yellow range. (Monitor, level detector, and transformer/rectifier check.)

(10) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in the yellow range. Release PRESS TO TEST switch.

NOTE: When self-test switch is moved to position 5, unless the airspeed error signal is exactly zero, the meter needle may slowly creep toward peg. Pressing the PRESS TO TEST switch will cause the needle to return to the yellow range or below.

(11) Place self-test switch in position 5. Press and hold PRESS TO TEST switch. Meter indication should be in the yellow range. (Amplifier limiter and monitor output check.) Move AUTOTHROT engage lever to ENGAGE. All throttle levers should move aft, and meter indication should remain in the yellow range. Release PRESS TO TEST switch. Throttle levers should stop moving.

(12) Place self-test selector switch to OFF. Move all throttle levers to aft stop, and move AUTOTHROT engage lever to DISENGAGE.

D. Airspeed Control Error Output

NOTE: For this test, select the captain's airspeed indicator as the command indicator. The throttle levers should operate in range from 1.25 inches to 3.5 inches.

(1) Move AUTOTHROT lever to ENGAGE, and verify that indicated airspeed is holding at 160 ±5 knots.

(2) Move reference index in captains airspeed indicator to 180 ±5 knots. Throttle levers should move forward.

(3) Move the reference index to 140 ±5 knots. The throttle levers should move aft.

NOTE: Repeat steps (2) and (3) selecting F.O. IAS. Return AIRSPEED ERROR SELECTOR switch to CAPT IAS.

(4) Move reference index to coincide with indicated airspeed.

(5) Move GUST LOCK lever to LOCKED position.

(6) Manually move control command full nose up attitude. Throttle levers should move forward.

(7) Manually move control column to command full nose-down attitude. Throttle levers should move aft.

(8) Move control column to neutral and move AUTOTHROT lever to DISENGAGE.

(9) Move GUST LOCK lever to UNLOCKED position.

E. Servo Authority Limit Test

(1) Verify indicated airspeed is maintained at 160 ±5 knots; move all throttle levers to forward stop, and move AUTOTHROT lever to ENGAGE.

(2) Move reference index on Captain's Airspeed Indicator to 120 ±5 knots. All throttle levers should move aft and stop 1 ±1/2 inches forward of aft stop.

NOTE: If all throttle levers do not move from identical positions, discrepancies in lever position will exist when aft motion stops.

(3) Move No. 1 throttle lever to 2 1/2 inches forward of aft stop. Remaining levers should move to aft stop. No. 1 throttle lever should move to 1 inch forward of aft stop.

(4) Move AUTOTHROT lever to DISENGAGE.

(5) Repeat Steps (3) and (4) using No. 4 throttle lever in place of No. 1.

(6) Move reference index on captain's airspeed indicator to 190 ±5 knots, and move all throttle levers to aft mechanical stop.

(7) Move AUTOTHROT lever to ENGAGE. All throttle levers should move forward and stop 3 3/4 inches from aft stop.

(8) Move No. 2 throttle lever to aft stop. Remaining throttle levers should hold position.

(9) Align No. 2 throttle levers with remaining throttle levers, move all throttle levers to aft stop, and move AUTOTHROT lever to DISENGAGE.

F. Overpower Test

(1) Move AUTOTHROT lever to ENGAGE.

(2) Move all throttle levers to forward mechanical stop.

(3) Move reference index on captain's airspeed indicator to 140 ±5 knots, after assuring that the indicated airspeed is holding at 160 ±5 knots. Throttle levers should move aft.

(4) It should be possible to manually prevent the aft motion of the throttle levers by holding the levers.

(5) Move all throttle levers to aft stop, and move AUTOTHROT lever to DISENGAGE.

G. Test Termination

(1) Open all circuit breakers that were closed at the beginning of the tests.

(2) Disconnect and remove all test equipment, assuring that all aircraft pitot and static lines are connected or capped.

AUTOTHROTTLE - MAINTENANCE PRACTICES

1. General

A. This section contains a series of cockpit functional tests.

B. Should any of these tests fail, refer to the applicable trouble shooting section for corrective action.

2. Tools and Equipment Required

NOTE: Suitable substitutes may be used in lieu of the following listed items.

Item	Name	Number	Manufacturer	Use
A	SIMULATOR, Pitot & STATIC	VPT-10C	International Dynamics Corp.	To supply air speed reference to the airspeed indicator.
B	Measuring tape, or Flexible rule			Measure throttle lever movement along curved surface of control pedestal.

3. Preliminary Test Requirements

A. Rigging of fuel control system and engine throttles should be complete and in working order.

B. The airspeed control system associated with the Autothrottle System should be checked out previously and in working order.

C. Remove hydraulic power from airplane.

D. Open the following circuit breakers and have them remain open throughout this test procedure.

ALL FUEL BOOST PUMP
ALL ENGINE START PUMP
ALL IGNITION

4. Application of Power

NOTE: The following circuit breakers should remain closed for the duration of the test, unless specifically instructed otherwise.

AUTOTHROTTLE
GO AROUND - 1
AUTOTHROTTLE OFF WARNING LIGHTS
GO AROUND - 2
FIRST OFFICER'S HORIZON DISPLAY
FIRST OFFICER'S VERTICAL GYRO
GROUND SPOILER CONTROL
ANTI-SKID SYSTEM CONTROL

NOTE: During this test, the VERTICAL GYRO switch should be placed to NORM. (Autothrottle takes its input signal from No. 2 gyro.)

A. Test Autothrottle Control System

NOTE: The elevator trailing edge should be at neutral position (10 ±3/16 inches below the marked rivet on the left side of the tail cone) before performing the following procedures. The neutral position is obtained with the horizontal stabilizer at zero degrees and the GUST LOCK in the LOCKED position.

(1) Set AIRSPEED ERROR SELECTOR SWITCH (if installed) to CAPT AIS.

(2) Connect Pitot/Static Simulator to Captain's and First Officer's pitot tubes and static ports.

(3) Slowly adjust pitot and static pressure to obtain 160 ±5 knots indication on Captain's Airspeed Indicator.

CAUTION: ALWAYS MAINTAIN PITOT PRESSURE HIGHER THAN STATIC PRESSURE. DO NOT EXCEED MAXIMUM INDICATION OF AIRSPEED INDICATOR TO ELIMINATE POSSIBLE DAMAGE TO TEST EQUIPMENT.

(4) Set reference index on Captain's and First Officer's Airspeed Indicators to coincide with indicated airspeed.

NOTE: If the THROTTLE lights on the instrument failure warning annunciators are on, press Captain's or First Officer's RESET ANNUN switch. Lights should go off.

(5) Move AUTOTHROT engage lever to ENGAGE. Lever should hold.

(6) Move all throttle levers to forward stop. AUTOTHROT lever should hold.

(7) Press DISENGAGE switch located on the outside of No. 1 throttle lever.

(8) AUTOTHROT lever should move to DISENGAGE. THROTTLE lights on both Captain's and First Officer's NAV INSTR FAILURE WARNING ANNUNCIATOR should come on.

(9) Press Captain's RESET ANNUN switch. Lights should go off.

(10) Move AUTOTHROT lever to ENGAGE.

(11) Press DISENGAGE switch located on outboard side of No. 4 throttle lever. AUTOTHROT lever should move to DISENGAGE and THROTTLE lights should come on.

(12) Press First Officer's RESET ANNUN switch. Throttle lights should go off.

(13) Move AUTOTHROT lever to ENGAGE.

(14) Move No. 2 throttle lever to aft stop, and slowly move No. 2 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, AUTOTHROT lever should move to DISENGAGE, and THROTTLE lights should come on.

(15) Move No. 2 throttle lever toward forward thrust range.

(16) Move AUTOTHROT lever to ENGAGE. THROTTLE lights should go off.

<u>NOTE</u>: For the remainder of the test procedure, whenever the AUTOTHROT lever is in the ENGAGE position, the THROTTLE lights in both the Captain's and First Officer's NAV INSTR FAILURE WARNING ANNUNCIATOR(S) should be off. Whenever the AUTOTHROT levers move to the DISENGAGE position, the throttle lights should come on. Ignore these conditions.

(17) Move No. 3 throttle lever to aft stop, and slowly move No. 3 reverse thrust lever toward full reverse thrust. Before reverse thrust lever reaches its mechanical stop, AUTOTHROT lever should move to DISENGAGE and THROTTLE lights should come on.

(18) Move No. 3 Throttle lever to forward thrust range.

(19) Move AUTOTHROT lever to ENGAGE. THROTTLE lights should go off.

(20) Open VERTICAL GYRO -2 circuit breaker. (Supplies monitor signal to Computer/Amplifier.) AUTOTHROT lever should move to DISENGAGE.

(21) Close VERTICAL GYRO -2 circuit breaker, and move AUTOTHROT lever to ENGAGE.

(22) Press GO AROUND switch located on No. 2 throttle lever. AUTOTHROT lever should move to DISENGAGE.

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F. ANTI-SKID AUTOTHROTTLE Interlock

(1) Mark II Anti-Skid System (if installed) see Figure 201.

(a) Move autothrottle lever to engage.

(b) Open ground spoiler-control and anti-skid system control circuit breakers.

(c) Remove anti-skid control located in the accessory Compartment; Sta. 640.

(d) On plug P1-1200 of anti-skid control rack, jumper pin 32 to pin 12.

(e) Close ANTI-SKID SYSTEM CONTROL and GROUND SPOILER CONTROL circuit breakers.

CAUTION: NORMAL ELECTRICAL POWER TO VARIOUS SYSTEMS WILL BE INTERRUPTED WHEN THE NOSE WHEEL SCISSOR SWITCH TORQUE ARM IS MOVED TO SIMULATE A NOSE WHEEL EXTENDED CONDITION. MAKE CERTAIN THAT ESSENTIAL SERVICES ARE NOT INTERRUPTED. MAKE CERTAIN THAT ALL SWITCHES AND CONTROLS OF AFFECTED SYSTEMS ARE IN CORRECT POSITION TO PREVENT INADVERTENT OPERATION OF EQUIPMENT WHEN RETURNING TO NOSE WHEEL COMPRESSED CONDITION.

(f) Remove pin from nose wheel scissor switch torque arm and move torque arm to simulate a nose wheel extended condition.

(g) Autothrottle lever should move to disengage.

(h) Move nose wheel scissor switch torque arm to simulate a nose wheel compressed condition.

(i) Open anti-skid system control and ground spoiler control circuit breakers.

(j) Remove jumper from between pins 32 and 12 on plug P1-1200 of anti-skid control rack.

(k) On plug P1-1200 of the anti-skid control rack jumper pin 32 to pin 29.

(l) Close anti-skid system and ground spoiler control circuit breakers.

(m) Move autothrottle lever to engage position.

(n) Move nose wheel scissor switch torque arm to simulate a nose wheel extended condition.

(o) Autothrottle lever should move to disengage position.

(p) Return nose wheel scissor switch torque arm to its original position and replace pin.

(q) Open anti-skid and ground spoiler control circuit breakers.

(r) Remove jumper from between pins 32 and 29 on plug P1-1200 of anti-skid control rack.

(s) Replace anti-skid control unit.

(t) Return anti-skid control system and ground spoiler control system circuit breakers to their original position.

(2) Mark III Antiskid System (if applicable) see Figure 201

(a) Close spoiler lockout circuit breakers.

(b) Move autothrottle lever to engage position.

(c) Move flight engineer's main landing gear spoiler test switch to No. 1 position.

(d) Autothrottle lever should move to disengage.

(e) Move autothrottle lever to engage position.

(f) Move flight engineer's main landing gear spoiler test switch to No. 2 position.

(g) Autothrottle lever should move to the disengage position.

(h) Open spoiler lockout circuit breakers.

C. Computer/Amplifier - Self Test

(1) Assure that self-test meter on Computer/Amplifier indicates 30 vdc.

(2) Move all throttle levers to mid-position.

(3) Place self-test selector switch on computer/amplifier to position 1. Meter indication should be below yellow range. (Acceleration input signal check.)

(4) Press and hold computer/amplifier PRESS TO TEST switch. Within 20 seconds meter indication should be in yellow range. Release PRESS TO TEST switch.

(5) Place self-test selector switch in position 2. Meter indication should be below yellow range. (Airspeed processor check.)

(6) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in yellow range. Release PRESS TO TEST switch.

(7) Place self-test selector switch in position 3. Meter indication should be below yellow range. (Complimentary filter, synchronization loop, and tachometer check.)

(8) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in yellow range. Release PRESS TO TEST switch.

(9) Place self-test selector switch in position 4. Meter indication should be below yellow range. (Monitor, level detector, and transformer/rectifier check.)

(10) Press and hold PRESS TO TEST switch. Within 20 seconds meter indication should be in yellow range. Release PRESS TO TEST switch.

NOTE: When self-test switch is moved to position 5, unless the airspeed error signal is exactly zero, the meter needle should slowly creep toward peg. Pressing the PRESS TO TEST switch will cause the needle to return to the yellow range or below.

(11) Place self-test switch in position 5. Press and hold PRESS TO TEST switch. Meter indication should be in yellow range. (Amplifier limiter and monitor output check.) Move AUTOTHROT engage lever to ENGAGE. All throttle levers should move aft and meter should remain in yellow range. Release PRESS TO TEST switch. Throttles should stop moving.

(12) Place self-test selector switch to OFF. Move all throttle levers to aft stop, and move AUTOTHROT engage lever to DISENGAGE.

D. Airspeed Control Error Output

NOTE: If AIRSPEED ERROR SELECTOR SWITCH is installed, for this test select the Captain's Airspeed Indicator as the command indicator. The throttle levers should be operated in range of from 1.25 inches to 3.5 inches. If noted switch is not installed, test will be completed using Captain's AIS.

(1) Move AUTOTHROT lever to ENGAGE, and verify that indicated airspeed is holding at 160 (±5) knots.

(2) Move reference index on Captain's Airspeed Indicator to 180 (±5) knots. Throttle levers should move forward.

(3) Move reference index to 140 (±5) knots. Throttle levers should move aft.

<u>NOTE</u>: If AIRSPEED ERROR SELECTOR SWITCH is installed, repeat steps (2) and (3) using First Officers Airspeed Indicator.

(4) Move reference index to coincide with indicated airspeed.

(5) Move GUST LOCK lever to LOCKED position.

(6) Manually move control column to command full nose up attitude. Throttle levers should move forward.

(7) Manually move control column to command full nose-down attitude. Throttle levers should move aft.

(8) Move control column to neutral and move AUTOTHROT lever to DISENGAGE.

(9) Move GUST LOCK lever to UNLOCKED position.

E. Servo Authority Limit Test

(1) Verify indicated airspeed is maintained at 160 (±5) knots; move all throttle levers to forward stop, and move AUTOTHROT lever to ENGAGE.

(2) Move reference index on Captain's Airspeed Indicator to 120 (±5) knots. All throttle levers should move aft and stop 1 (±1/2) inches forward of aft stop.

<u>NOTE</u>: If all throttle levers do not move from identical positions, discrepancies in lever position will exist when aft motion stops.

(3) Move No. 1 throttle lever to 2 1/2 inches forward of aft stop. Remaining levers should move to aft stop. No. 1 throttle lever should move to 1 inch forward of aft stop.

(4) Move AUTOTHROT lever to DISENGAGE.

(5) Repeat steps (3) and (4) using No. 4 Throttle lever in place of No. 1.

(6) Move reference index on Captain's Airspeed Indicator to 190 (±5) knots and move all throttle levers to aft mechanical stop.

(7) Move AUTOTHROT lever to ENGAGE. All throttle levers should move forward and stop 3 3/4 inches from aft stop.

(8) Move No. 2 throttle lever to aft stop. Remaining throttle levers should hold position.

(9) Align No. 2 throttle levers with remaining throttle levers, move all throttle levers to aft stop, and move AUTOTHROT lever to DISENGAGE.

F. Overpower Test

(1) Move AUTOTHROT lever to ENGAGE.

(2) Move all throttle levers to forward mechanical stop.

(3) Move reference index on Captain's Airspeed Indicator to 140 (±5) knots, after assuring that the indicated airspeed is holding at 160 (±5) knots. Throttle levers should move aft.

(4) It should be possible to manually prevent aft motion of throttle levers by holding levers.

(5) Move all throttle levers to aft stop, and move AUTOTHROT lever to DISENGAGE.

G. Test Termination

(1) Open all circuit breakers that were closed at beginning of tests.

(2) Disconnect and remove all test equipment, assuring that all aircraft pitot and static lines are connected or capped.

(2) Open following circuit breakers.

(a) All fuel boost pumps

(b) All engine start pumps

(c) All ignition

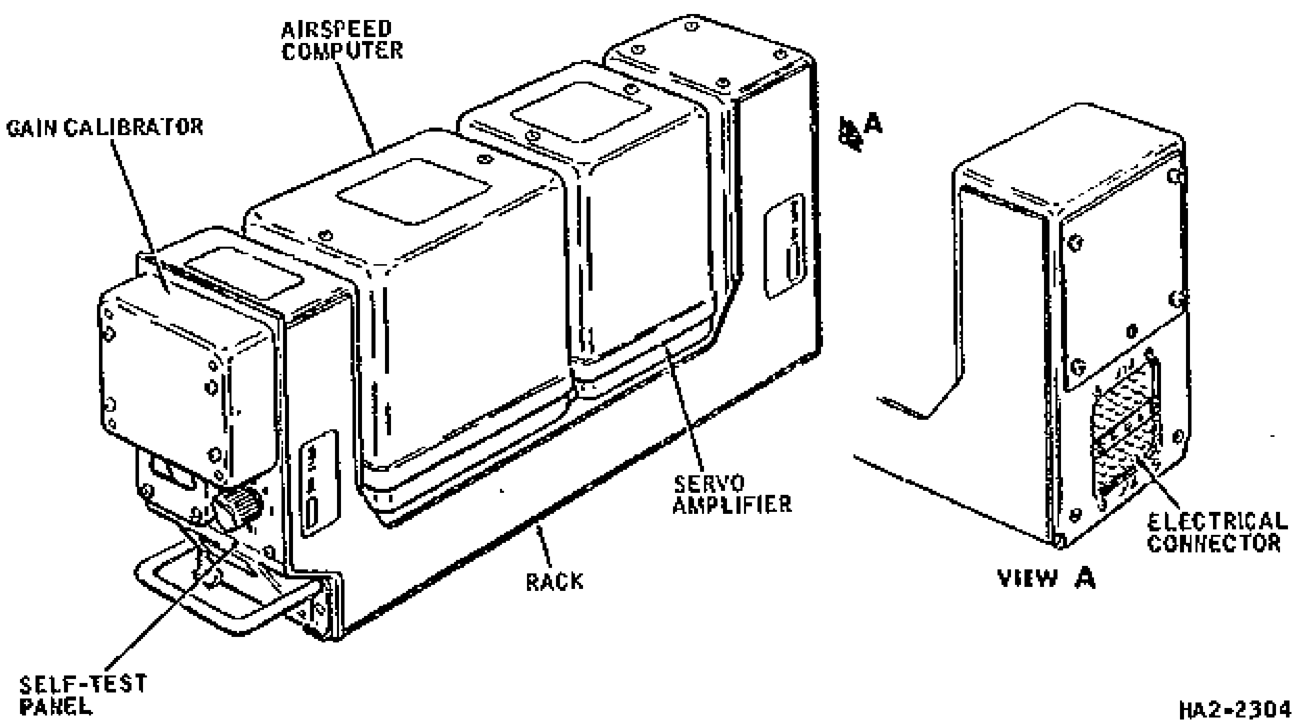
(d) Airspeed instruments.

(3) Move all throttle levers to a position midway between their mechanical stops.

(4) Locate self-test switch and self-test meter on front panel of auto throttle computer/amplifier (in radio rack in flight compartment).

(5) With self-test switch in off position, self-test meter should indicate in red range (30 vdc power supply).

NOTE: The push-to-test button on the computer self-test panel must be pressed for each test indication (each test switch position).



Auto Throttle Computer/Amplifier
Figure 201

(6) Rotate self-test switch to position No. 1; self-test meter should indicate below yellow range.

(7) Press and hold press-to-test switch; meter should indicate in yellow range within 20 seconds. Release press-to-test switch. (accelerometer check).

(8) Rotate self-test switch to position No. 2. Press and hold press-to-test switch; meter should indicate in yellow range within 20 seconds (processor check).

(9) Rotate self-test switch to position No. 3. Self-test meter should indicate below yellow range.

(10) Press and hold press-to-test switch; self-test meter should indicate in yellow range within 20 seconds (synchronization check). Release press-to-test switch.

(11) Rotate self-test switch to position No. 4; self-test meter should indicate below yellow range within 20 seconds.

(12) Press and hold press-to-test switch; self-test meter should indicate in yellow range within 30 seconds (monitor check).

(13) Release press-to-test switch.

(14) Rotate self-test switch to position No. 5; self-test meter should indicate below yellow range.

(15) Move auto throttle lever to engage position.

(16) Press and hold press-to-test switch. Throttle levers should move aft and self-test meter should indicate in yellow range. Release press-to-test switch (servo check).

(17) Move self-test switch to off position.

(18) Move all throttle levers to aft mechanical stop.

(19) Close all circuit breakers opened in step (2).

AUTO THROTTLE COMPUTER/AMPLIFIER - MAINTENANCE PRACTICES

1. General

   A. The auto throttle computer/amplifier is located in the radio rack in the flight compartment.

   B. Following routine installation or replacement of the computer/amplifier, the self-test procedure should be performed to determine acceptable operation of the unit as installed in the airplane.

   C. During the test, all components associated with operation of the auto throttle system should be installed in the airplane and in operating condition.

2. Removal/Installation Auto Throttle Computer/Amplifier

   A. Remove Auto Throttle Computer/Amplifier

      (1) Open auto throttle computer/amplifier circuit breaker.

      WARNING: TAG AND SAFETY THE CIRCUIT BREAKER.

      (2) Loosen two knobs on hold-down assemblies at front of computer/amplifier.

      (3) Carefully pull computer/amplifier straight out of radio rack, taking care not to damage or bend pins of electrical connector at back of computer/amplifier.

   B. Install Auto Throttle Computer/Amplifier

      (1) Make certain computer/amplifier circuit breaker is open.

      (2) Slide auto throttle computer/amplifier straight into mounting rack. Carefully apply firm pressure until electrical connector is properly engaged into receptacle on radio rack. Do not force fit. If mating is difficult, remove computer/amplifier and check to see if any pins are bent or out of alignment.

      (3) Engage hold-down assemblies to the lugs on computer/amplifier and tighten knurled knobs.

      (4) Close computer/amplifier circuit breaker.

3. Adjustment/Test Auto Throttle Computer/Amplifier

A. Self-Test Auto Throttle Computer/Amplifier

(1) Check that all components of auto throttle control system and associated systems are installed and properly connected.

(2) Speed command system should be previously checked out.

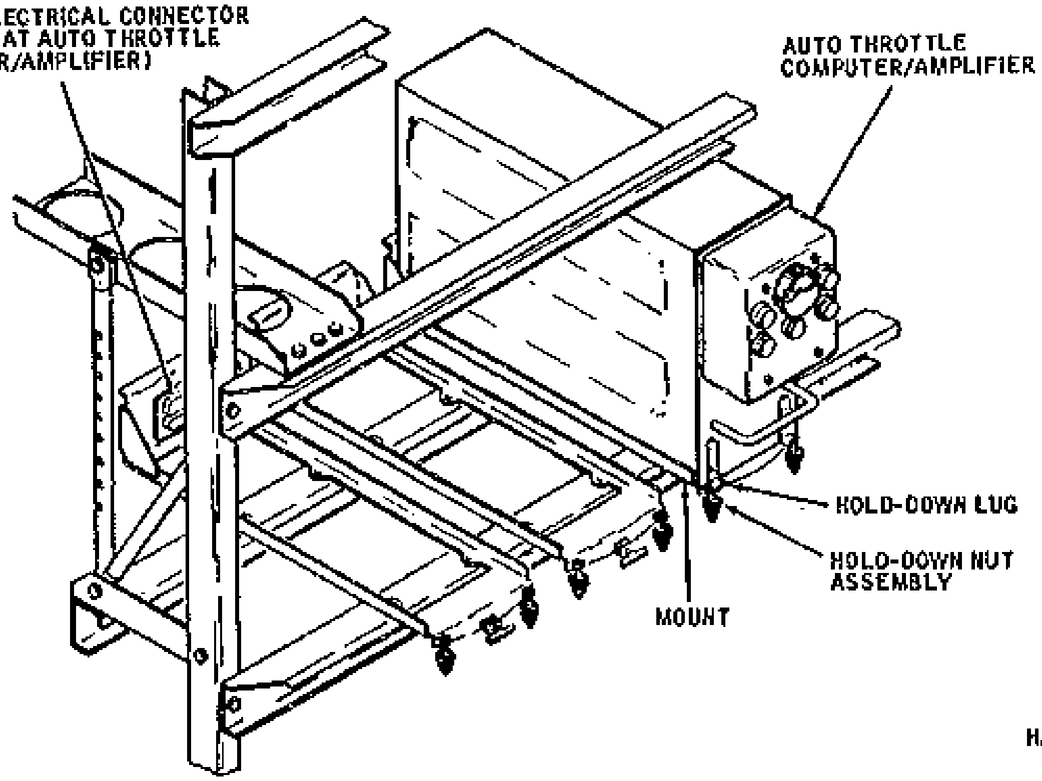
(3) Remove hydraulic power from airplane.

(4) Open following circuit breakers:

(a) All fuel boost pumps

(b) All engine start pumps

(c) All ignition



Auto Throttle Computer/Amplifier
Figure 201

NOTE: All throttle operations should be between upper and lower authority limits. If throttle levers are at either limit, no reading of self test meter on front panel of computer/amplifier should be attempted.

NOTE: Following procedures must be coordinated between self test panel of auto throttle computer/amplifier and throttle levers.

(5) Position self test selector switch, located on computer/amplifier front panel, to fixed phase position. Meter should indicate less than one scale division.

(6) Move auto throttle engage lever to engage position. Meter should indicate in green range.

(7) Move all throttle levers to idle position.

(8) Press and hold advance button located on front of computer/amplifier. Meter should remain in green range. Release advance button.

(9) Press and hold retard button. Meter should remain in green range. Release retard button. Meter should remain in green range.

(10) Position self test selector switch to amplifier output position.

(11) Press and hold advance button. Meter should indicate in yellow range. Release advance button. Meter should indicate less than one scale division.

(12) Press and hold retard button. Meter should indicate in yellow range. Release retard button. Meter should indicate less than one scale division.

(13) Position self test selector switch to tachometer position.

(14) Press and hold advance button. Meter should indicate in green range. Release advance button. Meter should indicate zero.

(15) Press and hold retard button. Meter should indicate in green range. Release retard button. Meter should indicate zero.

(16) Open auto throttle computer/amplifier circuit breaker. Auto throttle engage lever should move to disengage position. Lever should hold.

(17) Close auto throttle computer/amplifier circuit breaker.

(18) Position self test selector switch to alarm position.

(19) Press and hold P test button. Meter should indicate in green range and move to zero in approximately three seconds. It should not be possible to move auto throttle engage lever from disengage position. Release P test button.

(20) Move auto throttle engage lever to engage position.

(21) Simultaneously press and hold retard and P test buttons. Meter should indicate in green range and move to zero in approximately three seconds. Auto throttle engage lever should move to disengage position.

(22) Release retard and P test buttons. Move auto throttle engage lever to engage position.

(23) Move throttle levers to forward mechanical stop.

(24) Simultaneously press and hold advance and P test buttons. Meter should indicate in green range and move to zero in approximately three seconds. Auto throttle engage lever should move to disengage position.

(25) Release advance and P test buttons.

(26) Move all throttle levers to aft mechanical stop.

(27) Close all circuit breakers opened in step (4).

AUTO THROTTLE ACCELEROMETER - MAINTENANCE PRACTICES

1. General

   A. The accelerometer provides a forward acceleration signal to the auto throttle control system. The accelerometer is located adjacent to the aft bulkhead of the forward cargo compartment, approximately 15 inches below the floor line.

   B. The accelerometer has a built-in provision for self-testing. This includes self-test coils and associated circuitry to simulate the effect of forward acceleration within the unit. The dc excitation voltage is supplied by the auto throttle computer/amplifier.

   C. The accelerometer is a sealed unit and maintenance adjustments are not required.

2. Removal/Installation Auto Throttle Accelerometer

   A. Remove Accelerometer

      (1) Open auto throttle computer/amplifier circuit breaker.

      WARNING: TAG AND SAFETY THE CIRCUIT BREAKER.

      (2) Disconnect electrical connector from accelerometer and cover with protective cap.

      (3) Disconnect ground lead from ground stud.

      (4) Remove accelerometer from butting plate by means of three mounting bolts.

      CAUTION: THE ACCELEROMETERS MUST BE HANDLED WITH EXTREME CARE. DO NOT HANG THE UNIT BY ITS PIGTAIL CONNECTOR.

      (5) Store and ship accelerometer in cushioned box.

   B. Install Accelerometer

      (1) Check that auto throttle computer/amplifier circuit breaker is open.

      NOTE: When installing new accelerometer in airplane, make sure that the part number and dash number are the same as the unit replaced.

      (2) Install accelerometer, making sure that arrows on accelerometer are aligned with proper axis of airplane as shown on nameplate attached to airplane structure. Unit must be installed flush against mounting pad. Secure three mounting bolts with their nuts and lockwashers.

NOTE: Although alignment of accelerometer in airplane is critical, the mounting pad and mounting holes have been carefully aligned during initial factory installation. Unless structural damage has occurred, this alignment need not be checked during routine maintenance replacement of an accelerometer.

(3) Connect ground lead to ground stud.

(4) Remove cap from electrical connector and connect accelerometer to electrical receptacle on airplane.

(5) Close auto throttle computer/amplifier circuit breaker.

3. Adjustment/Test Accelerometer

A. Self-Test Accelerometer

(1) Open circuit breaker associated with airspeed system.

(2) Locate self-test switch on front panel of auto throttle computer/amplifier.

(3) Check that switch is in off position; self-test meter should read in red range (checks 30 vdc power supply to auto throttle system).

(4) Turn self-test switch to position 1; self-test meter should read in yellow range within 20 seconds (excites self-test coil in accelerometer and produces synthetic forward acceleration signal).

(5) Return self-test switch to off position.

(6) Close circuit breaker associated with airspeed system.

(7) Place all throttle levers in full aft position.

AUTO THROTTLE SERVO DRIVE - MAINTENANCE PRACTICES

1. General

A. The servo drive is located at the forward end of the center pedestal in the flight compartment.

B. Removal/installation procedures are for the complete package, which includes a servo drive motor, an airplane gear pack, and drive chain. The motor can be removed from the installed system by removing only the electrical connector and the bolts, attaching motor to the gear pack. Removal/installation of only the motor will not disturb the chain adjustment.

2. Removal/Installation Servo Drive

A. Remove Servo Drive

(1) Open auto throttle computer/amplifier circuit breaker, located on EPC circuit breaker panel.

WARNING: TAG AND SAFETY CIRCUIT BREAKER.

(2) Disconnect electrical connector from servo drive.

(3) Remove spring lock connecting link from servo drive chain and remove chain from servo drive sprocket.

(4) Support servo drive and remove mounting bolts.

B. Install Servo Drive Unit

(1) Make certain auto throttle computer/amplifier circuit breaker is open.

(2) Install servo drive.

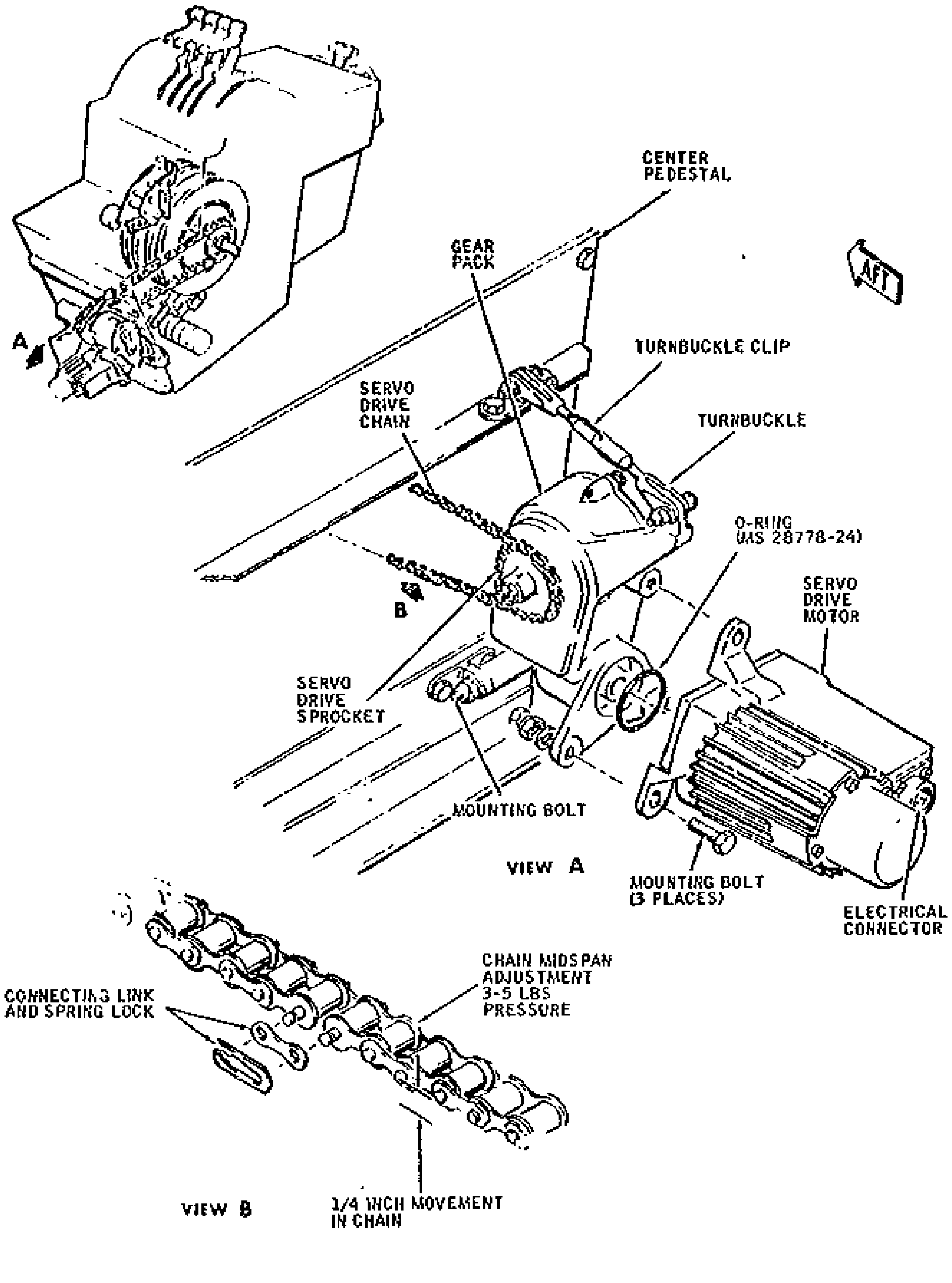
(3) Install servo drive chain and connect chain ends with spring lock connecting link.

(4) Adjust turnbuckle at upper mounting of servo drive to produce 1/4-inch midspan movement in chain with 3- to 5-pound force.

(5) Install turnbuckle clip.

(6) Connect electrical connector to servo drive.

(7) Close auto throttle computer/amplifier circuit breaker.



Servo Drive Removal/Installation
Figure 201

3. Adjustment/Test Servo Drive

A. Test Servo Drive

(1) Depressurize hydraulic system (see Chapter 29).

(2) Open following circuit breakers:

(a) All fuel boost pumps

(b) All engine start pumps

(c) All ignition

(3) Manually place all four throttle levers in a position approximately 2 inches forward of aft mechanical stop.

(4) Move auto throttle engage lever to engage position; lever should hold in position and all throttles should move forward at a uniform rate.

(5) Locate self-test switch on front panel of auto throttle computer/ amplifier.

(6) Rotate self-test switch to position No. 5; all four throttle levers should move aft together at a uniform rate.

(7) Disengage auto throttle system.

(8) Move all four throttle levers to their full aft position.

(9) Close all circuit breakers opened in step (2).

AUTO THROTTLE SERVO DRIVE - MAINTENANCE PRACTICES

1. General

A. The servo drive is located at the forward end of the center pedestal in the flight compartment.

B. Remove/installation procedures are for the complete package, which includes a servo drive motor, an airplane gear pack, and drive chain. The motor can be removed from the installed system by removing only the electrical connector and the bolts, attaching motor to the gear pack. Removal/installation of only the motor will not disturb the chain adjustment.

2. Removal/Installation Servo Drive

A. Remove Servo Drive

(1) Open auto throttle computer/amplifier circuit breaker located on EPC circuit breaker panel.

WARNING: TAG AND SAFETY CIRCUIT BREAKER.

(2) Disconnect electrical connector from servo drive.

(3) Remove spring lock connecting link from servo drive chain and remove chain from servo drive sprocket.

(4) Support servo drive and remove mounting bolts.

B. Install Servo Drive Unit

(1) Make certain auto throttle computer/amplifier circuit breaker is open.

(2) Install servo drive.

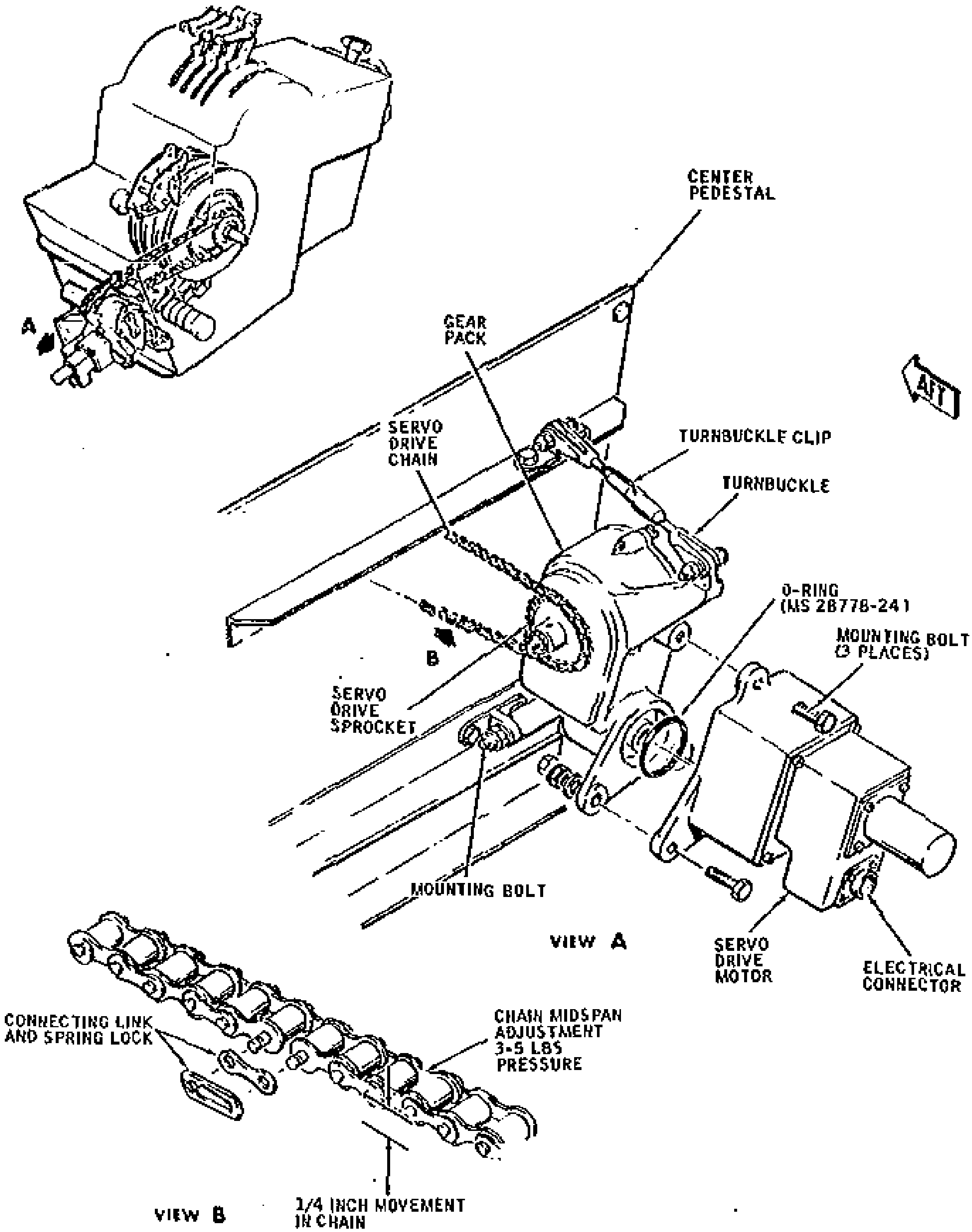
(3) Install servo drive chain and connect chain ends with spring lock connecting link.

(4) Adjust turnbuckle at upper mounting of servo drive to produce 1/4-inch midspan movement in chan with 3- to 5-pound force.

(5) Install turnbuckle clip.

(6) Connect electrical connector to servo drive.

(7) Close auto throttle computer/amplifier circuit breaker.



Servo Drive Removal/Installation
Figure 201

3. Adjustment/Test Servo Drive

A. Test Servo Drive

(1) Place captain's flight director system in any mode except off or speed command, and open both ground control relay circuit breakers. Fast-slow indicator located on captain's flight director indicator should be away from center towards slow legend; speed command flag on captain's flight director indicator should be retracted from view.

(2) Move auto throttle engage lever to engage position. Lever should hold; all four throttles should move toward simultaneously.

(3) Place and hold speed command test switch located on forward overhead switch panel in fast position. Fast-slow indicator should move into fast region; all four throttles should move aft.

NOTE: This simple test verifies that the servo drive will move the throttles in the proper direction in response to commands from the auto throttle computer/amplifier. If a complete system test is warranted, refer to 22-30-0, page 201.

(4) Move auto throttle engage lever to disengage position. Auto throttle lights in instrument warning annunciators should come on.

(5) Press instrument warning reset button. Auto throttle lights should go off.

(6) Move all four throttle levers to full aft positions.

AUTO THROTTLE AUTHORITY SWITCHES - MAINTENANCE PRACTICES

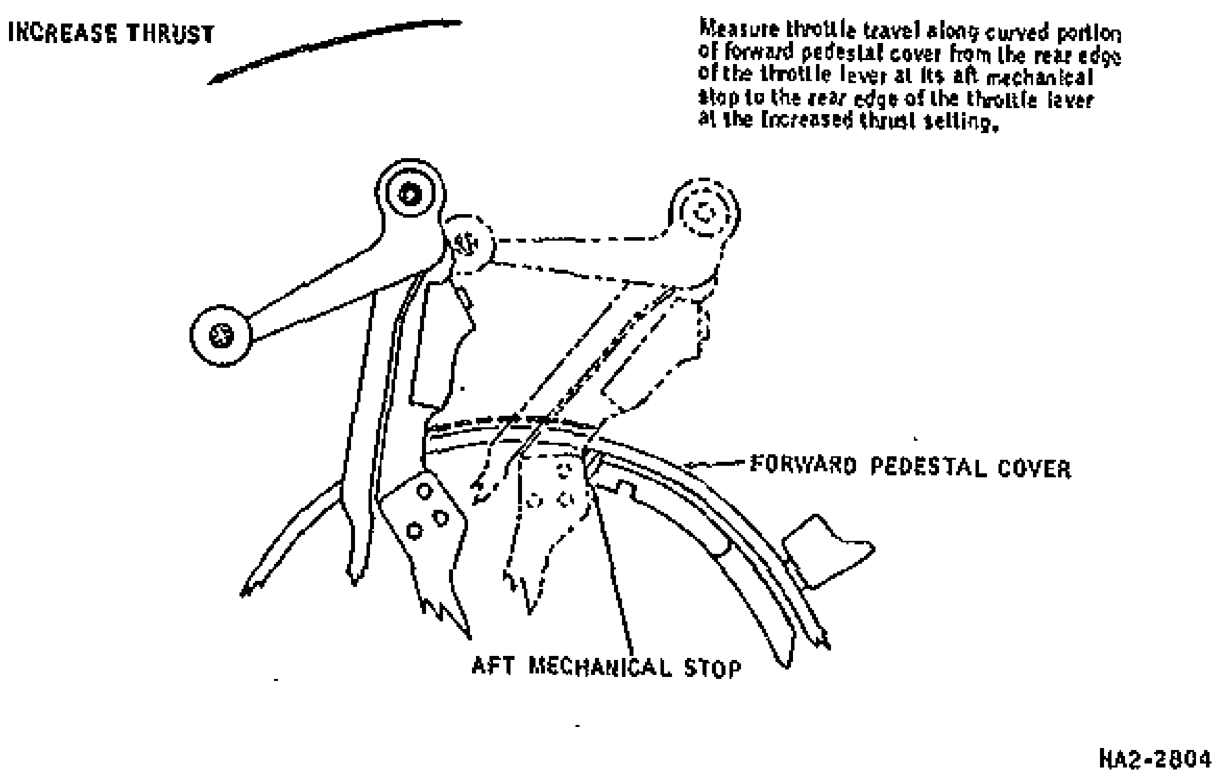
1. General

   A. The two auto throttle maximum authority switches are located in the pilot's control pedestal and are accessible through the pedestal side access panels. Each switch is actuated by a cam installed on the lower throttle assembly clevis arm of the corresponding inboard throttle. Adjustment procedures for each maximum authority switch are identical.

   B. The two minimum authority switches are installed on the thrust reverse gate control assembly located below the flight compartment floor at the forward and of the pilot's control pedestal. Each switch is actuated by movement of the corresponding outboard throttle lever. Adjustment procedures for each minimum authority switch are identical.

2. Tools and Equipment Required

   A. A ruler or measuring tape is required to measure throttle lever movement along the top curved surface of the pilot's control pedestal (see Figure 201).



Measurement Guide -- Throttle Lever Travel
Figure 201

3. Adjustment/Test Auto Throttle Authority Switches

A. Adjust Auto Throttle Maximum Authority Switches (see Figure 202).

(1) Position inboard throttle lever corresponding to switch to be adjusted 3 13/16 inches forward of aft mechanical stop.

(2) Loosen cam shaft retaining nut approximately 1 turn.

(3) Locate cam that actuates maximum authority switch.

NOTE: Item number of switch is ink-stamped on the structure adjacent to each switch (see Wiring Diagram Manual).

(4) Using slot screwdriver in cam slot, spread cam just enough to relieve tension of cam on shaft. Adjust cam to actuate switch as switch roller travels from low to high surface of cam.

CAUTION: EXCESSIVE SPREADING OF SLOT CAN DAMAGE CAM.

(5) Tighten cam shaft retaining nut to torque of 60 (±10) inch-pounds. Install Cotter pin.

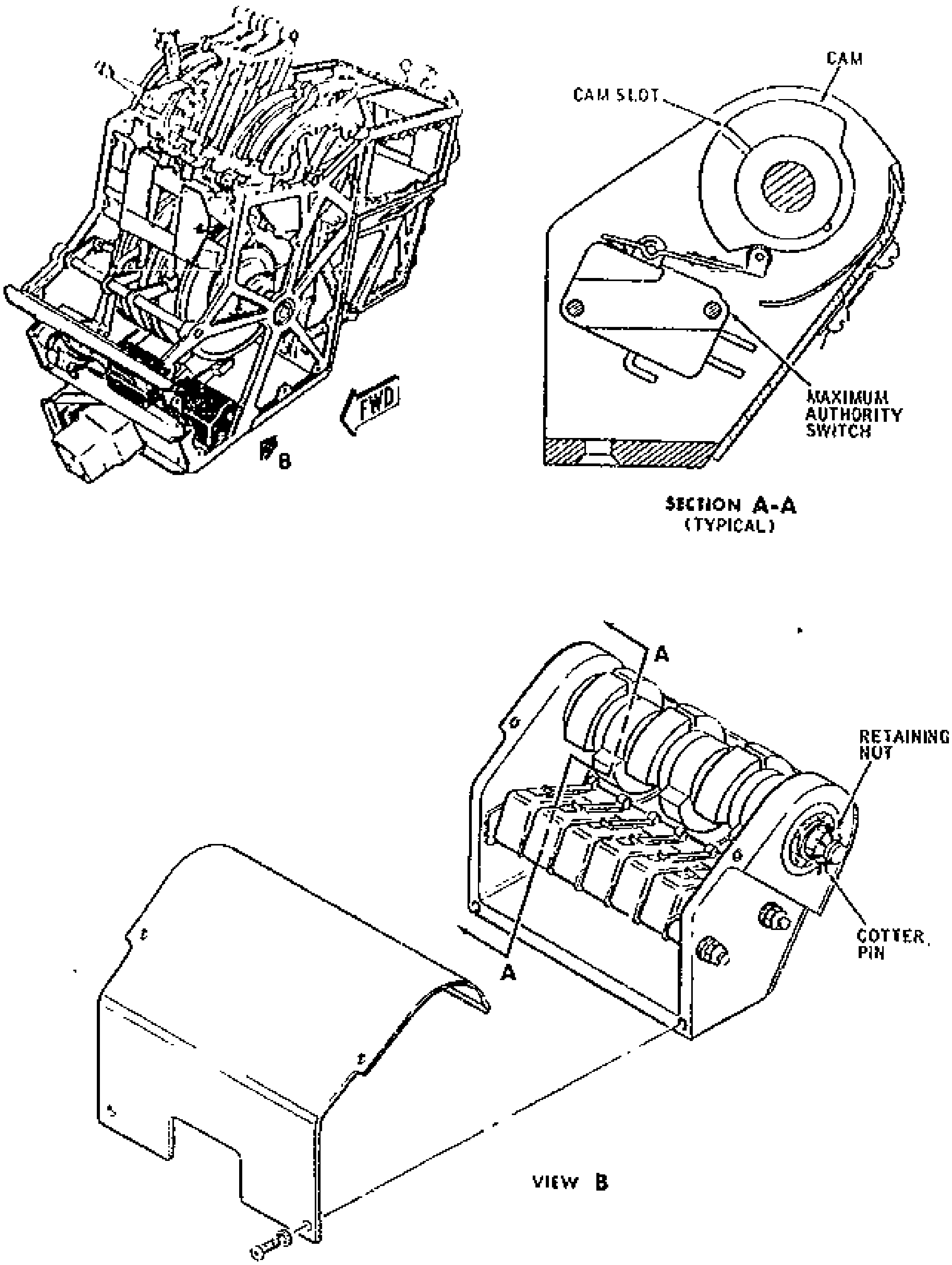
(6) Verify that maximum authority switch actuates as corresponding inboard throttle lever is moved from aft mechanical stop toward power on position. Switch should actuate when throttle lever is 3 13/16 (±1/16) inches from aft stop.

B. Adjust Auto Throttle Minimum Authority Switches (see Figure 203).

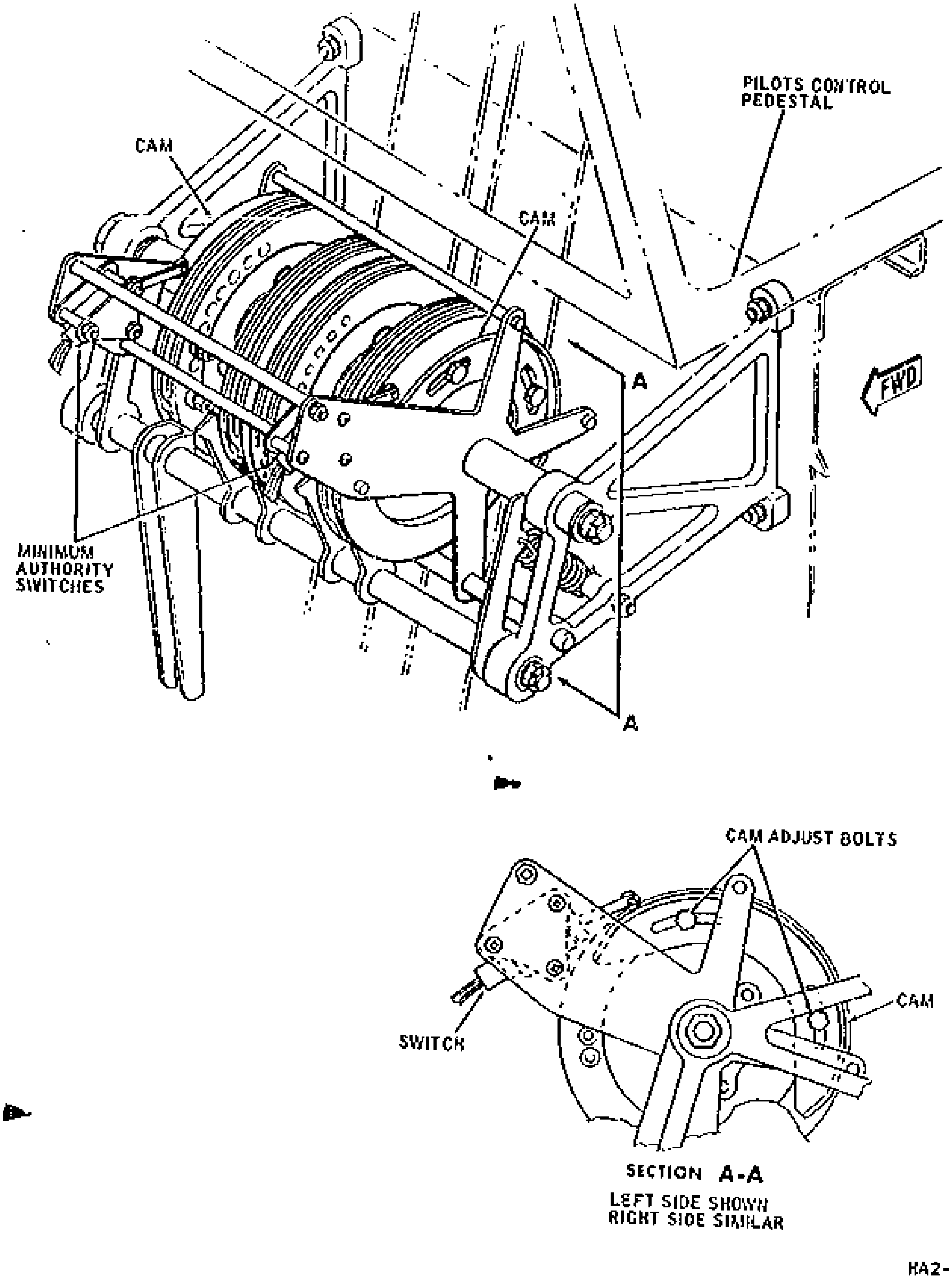
(1) Position outboard throttle lever corresponding to switch to be adjusted 1 inch forward of aft mechanical stop.

(2) Adjust cam to deactuate switch as switch roller travels from high portion of cam.

(3) Verify that minimum authority switch deactuates as corresponding outboard throttle lever is moved from power on position toward aft mechanical stop. Switch should deactuate when throttle lever is 1 (±1/16) inch from aft stop.



Maximum Authority Switch Adjustment
Figure 202



HA2-3782

Minimum Authority Switch Adjustment
Figure 203

AUTO THROTTLE AUTHORITY SWITCHES - MAINTENANCE PRACTICES

1. General

   A. The two minimum authority switches are installed on the thrust reverse gate control assembly located below the flight compartment floor at the forward end of the pilot's control pedestal. Each switch is actuated by movement of the corresponding outboard throttle lever. Adjustment procedures for each minimum authority switch are identical.

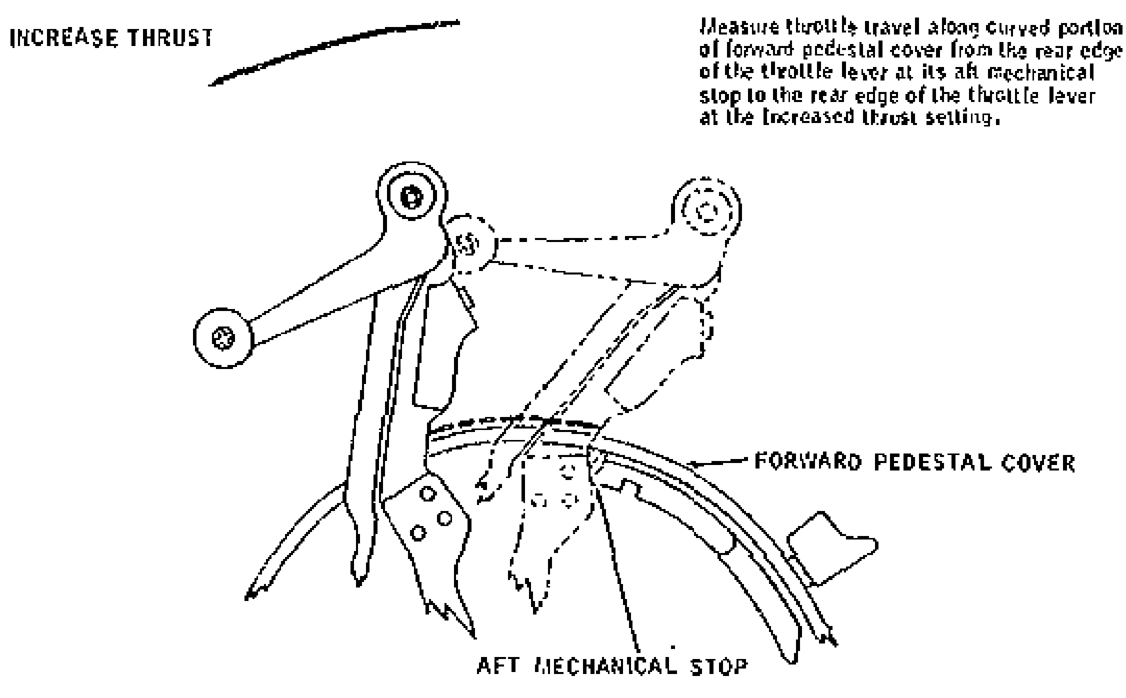
2. Tools and Equipment Required

   A. A ruler or measuring tape is required to measure throttle lever movement along the top curved surface of the pilot's control pedestal (see Figure 201).

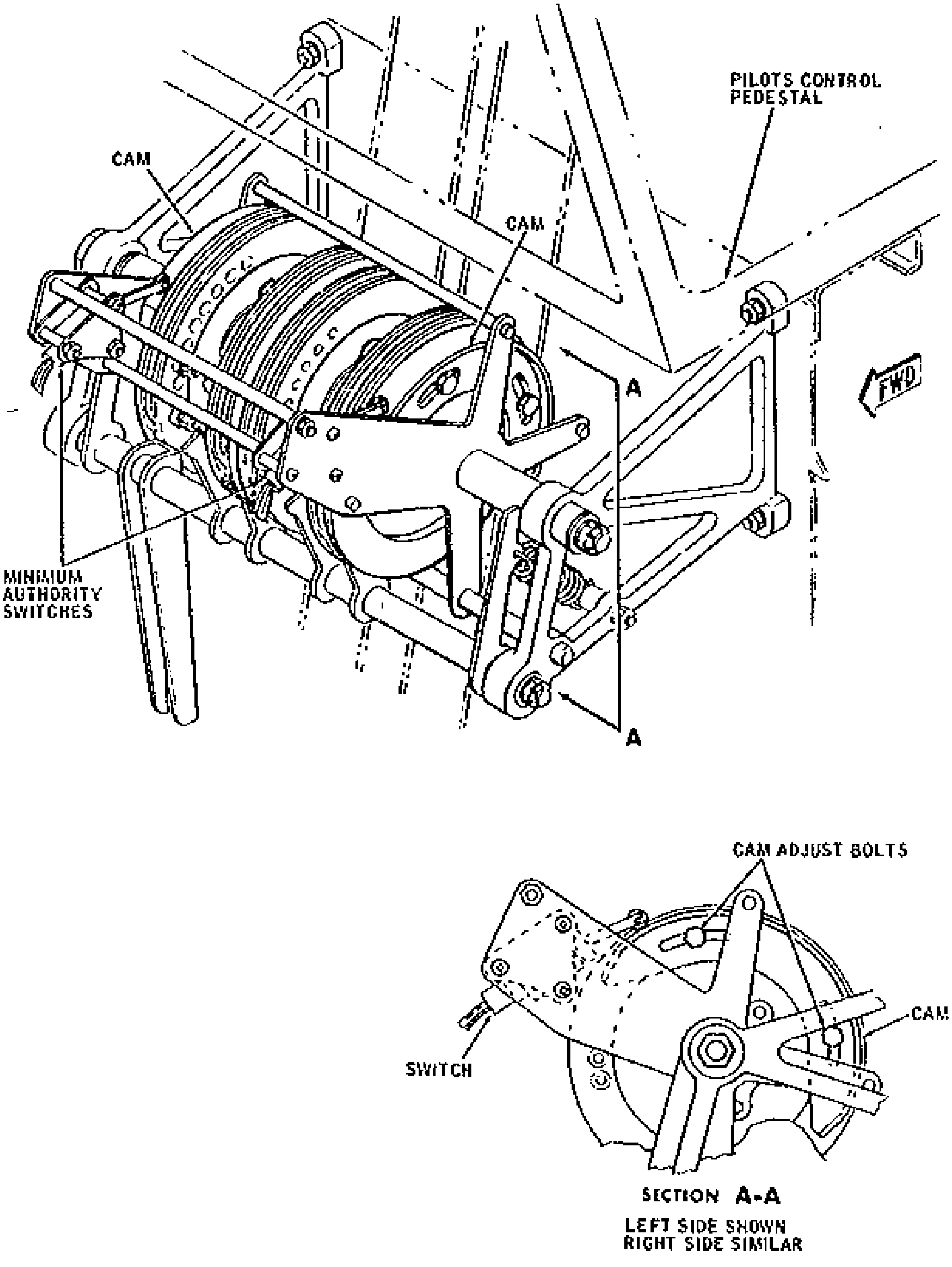
3. Adjustment/Test Auto Throttle Authority Switches

   A. Adjust Auto Throttle Minimum Authority Switches (see Figure 202).

      (1) Position outboard throttle lever corresponding to switch to be adjusted 1-inch forward of aft mechanical stop.



Measurement Guide -- Throttle Lever Travel
Figure 201



Minimum Authority Switch Adjustment
Figure 202

(2) Adjust cam to deactuate switch as switch roller travels from high portion of cam.

(3) Verify that minimum authority switch deactuates as corresponding outboard throttle lever is moved from power on position toward aft mechanical stop. Switch should deactuate when throttle lever is 1 (± 1/16) inch from aft stop.

REVERSE THRUST DISENGAGE SWITCHES - MAINTENANCE PRACTICES

1. General

   A. The two reverse thrust disengage switches are located in the pilot's control pedestal and are accessible through the pedestal side access panels. Each switch is actuated by a cam installed on the lower throttle assembly clevis arm of the corresponding inboard throttle. Adjustment procedures for each reverse thrust disengage switch are identical.

2. Tools and Equipment Required

   A. A ruler or measuring tape is required to measure reverse thrust lever movement from the top of the pilot's control pedestal to the centerline of the reverse thrust lever knob.

3. Adjustment/Test Reverse Thrust Disengage Switch (see Figure 201)

   A. Adjust Reverse Thrust Disengage Switch.

      (1) Position inboard throttle lever, corresponding to switch to be adjusted, at aft mechanical stop.

      (2) Position reverse thrust lever 5-1/4 (6-15/16 ±1/16 for airplanes with extended length reverse thrust levers) inches above top of pilot's control.

         NOTE: Measurement is made vertically from the pedestal cover to the centerline of the reverse thrust lever knob.

      (3) Loosen cam shaft retaining nut approximately 1 turn.

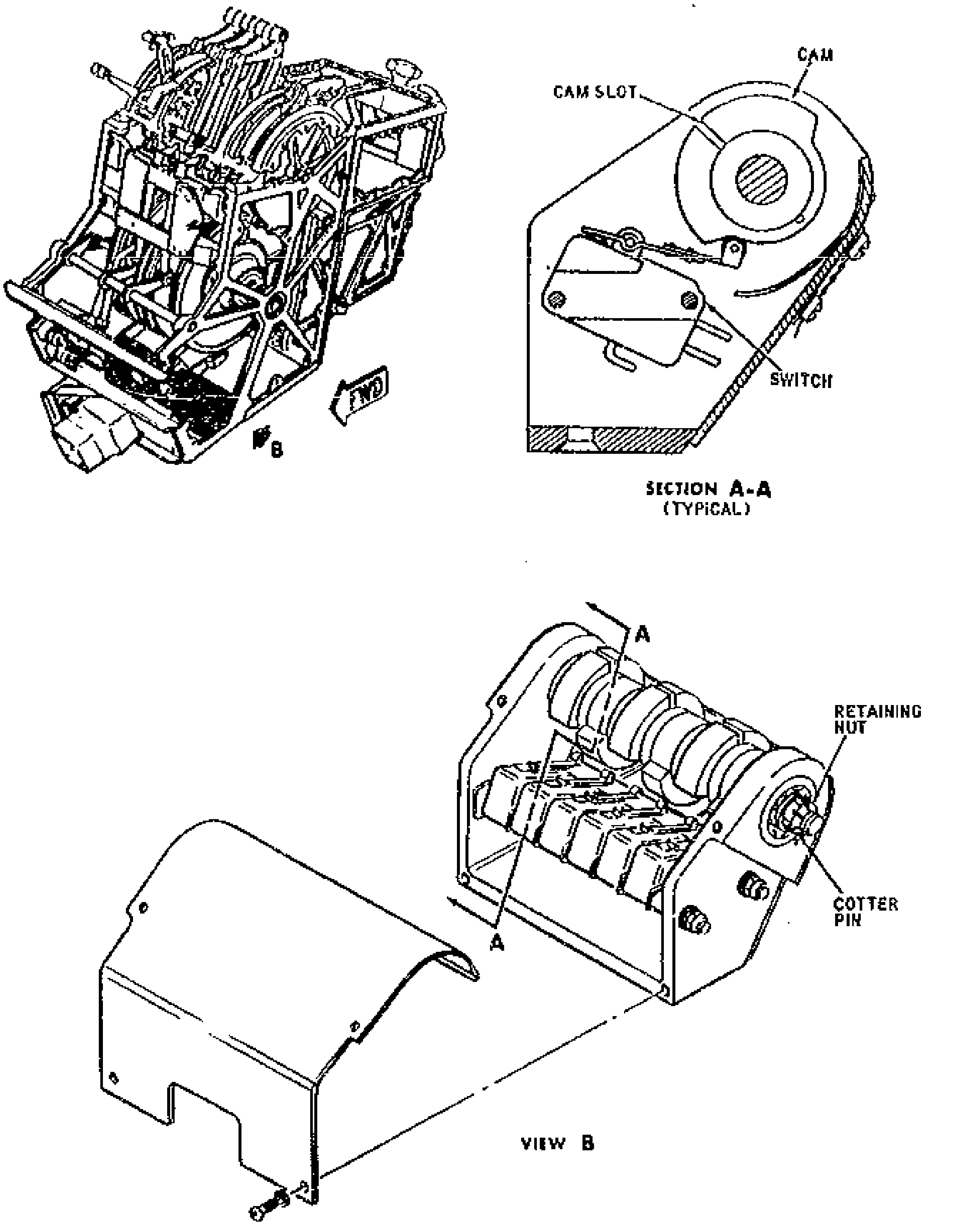
      (4) Locate cam that actuates reverse thrust disengage switch.

         NOTE: Item number of switch is ink-stamped on the structure adjacent to each switch (see Wiring Diagram Manual).

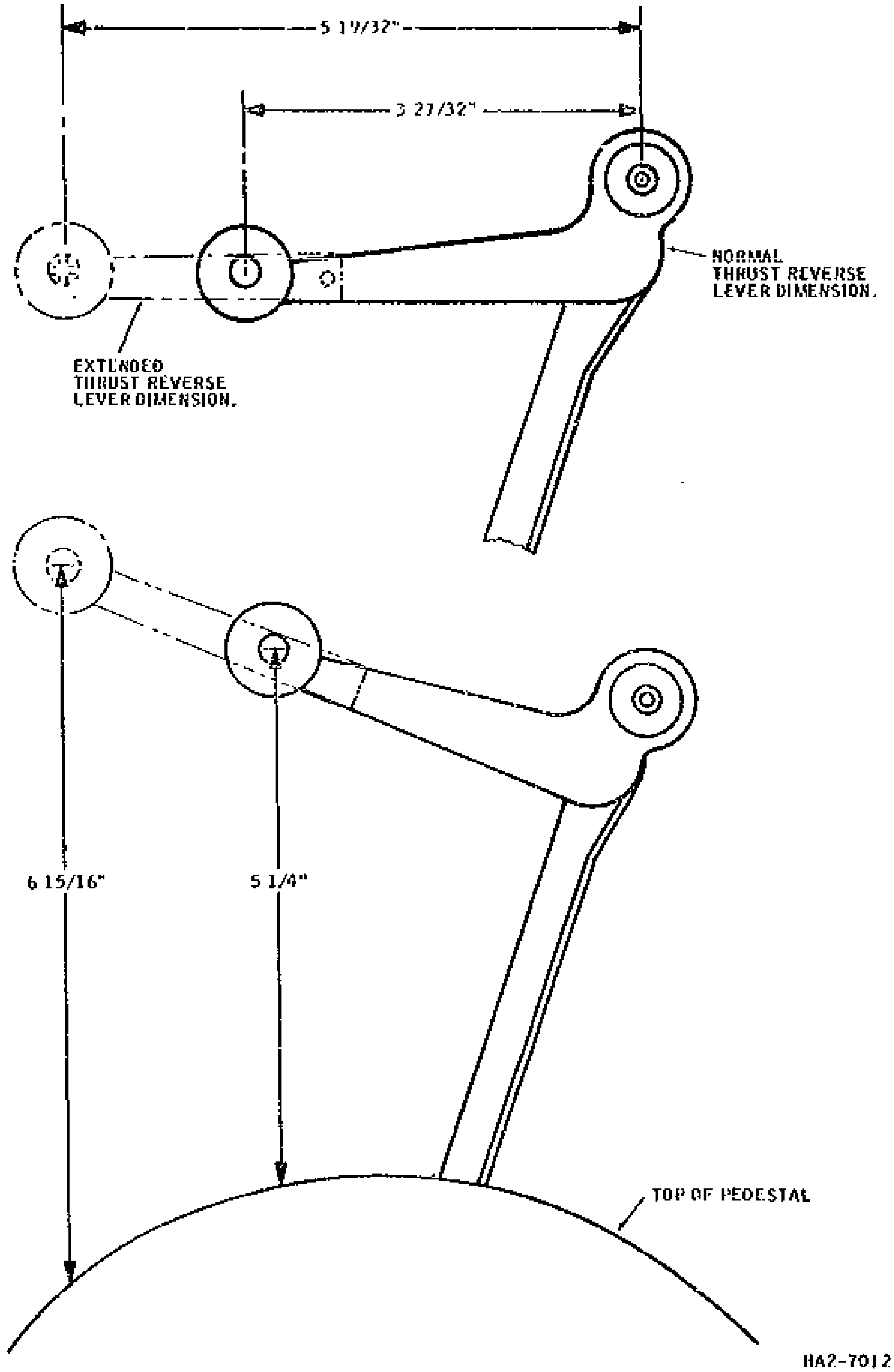
      (5) Using slot screwdriver in cam slot, spread cam just enough to relieve tension of cam on shaft. Adjust cam to deactuate switch as switch roller travels from low to high surface of cam.

         CAUTION: EXCESSIVE SPREADING OF SLOT CAN DAMAGE CAM.

      (6) Tighten cam shaft retaining nut to torque of 60 (±10) inch-pounds. Install cotter pin.



Reverse Thrust Disengage Switch Adjustment
Figure 201



Reverse Thrust Levers
Figure 202

(7) Verify that reverse thrust disengage switch deactuates as corresponding inboard reverse thrust lever is raised from normal forward thrust position towards reverse thrust position. Switch should deactuate when reverse thrust lever is 5-1/4 ±1/16 (6-15/16 ±1/16 for aircraft with extended length reverse thrust levers) inches above top of pilot's control pedestal.

ELEVATOR POSITION SENSOR - MAINTENANCE PRACTICES

1. General

A. The elevator position sensor is attached to the elevator upper stop bracket, located on the aft bulkhead in the empennage.

2. Tools and Equipment Required

A. A Mach Calibrator, 2024, Burton Manufacturing Company or an Air Data Calibrator, VTP-108, Intercontinental Dynamics Corporation, or equivalent, is required to supply airspeed reference to Mach/airspeed indicators when testing the elevator position sensor.

3. Adjustment/Test Elevator Position Sensor

A. Adjust Elevator Position Sensor

NOTE: The elevator pushrod and elevator stops must be properly adjusted (see 27-30-0, Adjustment/Test) before adjusting the sensor.

(1) Check that gust lock control lever, located on pilot's control pedestal, is in locked position and that elevator trailing edge is at neutral position.

NOTE: Elevator is in neutral position when trailing edge is 10 (±3/16) inches below marked rivet on left side of tail cone. This position is obtained with the horizontal stabilizer at zero degrees and the GUST LOCK lever in LOCKED position.

(2) Disconnect upper end of sensor pushrod from arm.

(3) Loosen pushrod jamnuts and adjust pushrod to length of 9-5/8 inches, measured between centers of attach bolt holes. Tighten jamnuts.

(4) Connect pushrod to arm.

(5) Loosen sensor clamp bolt.

(6) Rotate sensor to align index marks on sensor housing and shaft.

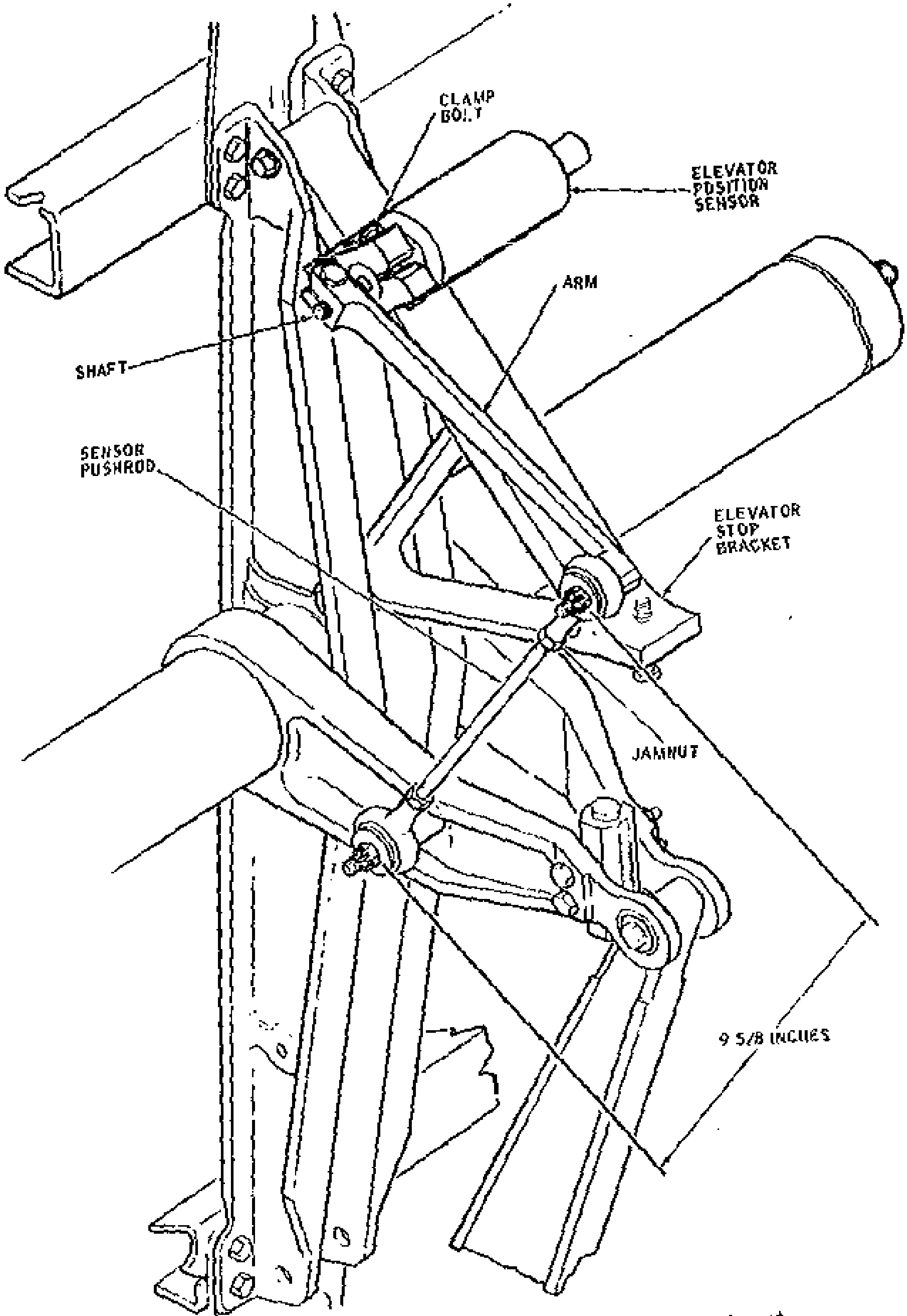
(7) Tighten sensor clamp bolt.

B. Test Elevator Position Sensor

(1) Open following circuit breakers located on EPC circuit breaker panel:

(a) All engine start pump circuit breakers.

(b) All engine ignition circuit breakers.



Elevator Position Sensor -- Adjustment
Figure 201

(2) Using Calibrator, adjust pitot and static pressure to obtain approximately 100 knots indication on Mach/airspeed indicators.

CAUTION: ALWAYS MAINTAIN PITOT PRESSURES HIGHER THAN STATIC PRESSURES. DO NOT EXCEED MAXIMUM INDICATION OF THE MACH/AIRSPEED INDICATORS.

NOTE: Airspeed indication is to be maintained during the following procedures.

(3) Set reference index on captain's and first officer's Mach/airspeed indicators to coincide with indicated airspeed.

(4) Move all throttle levers to approximately 3-1/2 inches forward of aft stops.

(5) Move gust lock control lever to unlock position.

(6) Manually move elevator trailing edge to neutral position.

NOTE: Elevator is in neutral position when trailing edge is 10 (± 3/16) inches below marked rivet on left side of tail cone.

(7) Place auto throttle lever in engage position.

NOTE: If throttle levers move when auto throttle is engaged, set reference index on Mach/airspeed indicators for no throttle movement.

(8) Manually move elevator trailing edge down. Throttle levers should move aft.

(9) When throttle levers stop moving, manually move elevator trailing edge up. Throttle levers should move forward.

(10) Move elevator trailing edge to neutral position.

(11) Place auto throttle lever in disengage position.

(12) Move all throttle levers to aft stops.

(13) Move gust lock control lever to lock position.

(14) Disconnect Calibrator.

(15) Close following circuit breakers located on EPC circuit breaker panel:

(a) All engine start pump circuit breakers.

(b) All engine ignition circuit breakers.

ELEVATOR POSITION SENSOR - MAINTENANCE PRACTICES

1. General

   A. The elevator position sensor is attached to the elevator upper stop bracket, located on the aft bulkhead in the empennage.

2. Adjustment/Test Elevator Position Sensor

   A. Adjust Elevator Position Sensor

      NOTE: The elevator pushrod and elevator stops must be properly adjusted (see 27-30-0, Adjustment/Test) before adjusting the sensor.

      (1) Check that gust lock control lever, located on pilot's control pedestal, is in lock position and that elevator trailing edge is at neutral position.

         NOTE: Elevator is in neutral position when trailing edge is 10 (± 3/16) inches below marked rivet on left side of tail cone.

      (2) Disconnect upper end of sensor pushrod arm.

      (3) Loosen pushrod jamnuts and adjust pushrod to length of 9-5/8 inches, measured between centers of attach bolt holes. Tighten jamnuts.

      (4) Connect pushrod to arm.

      (5) Loosen sensor clamp bolt.

      (6) Rotate sensor to align index marks on sensor housing and shaft.

      (7) Tighten sensor clamp bolt.

   B. Test Elevator Position Sensor

      (1) Open following circuit breakers located on EPC circuit breaker panel:

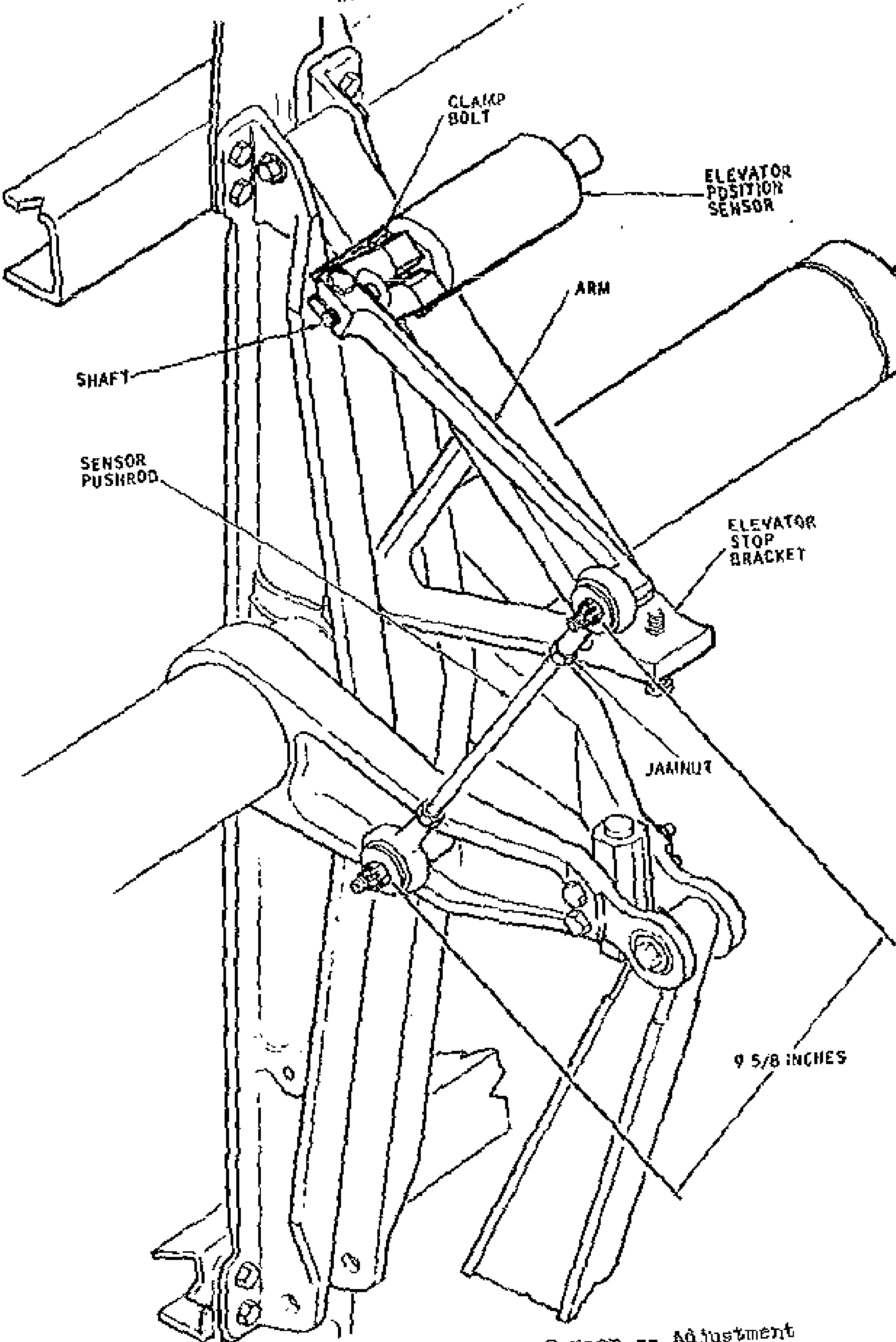
         (a) All engine start pump circuit breakers.

         (b) All engine ignition circuit breakers.

      (2) Set index bug of all EPR (engine pressure ratio) indicators to obtain reading of 1.40.

      (3) Set reference index on speed command indicator to coincide with indicated airspeed.

      (4) Move all throttle levers to approximately 3-1/2 inches forward of aft stops.



Elevator Position Sensor -- Adjustment
Figure 201

(5) Move gust lock control lever to unlock position.

(6) Manually move elevator trailing edge to neutral position.

NOTE: Elevator is in neutral position when trailing edge is 10 (± 3/16) inches below marked rivet on left side of tail cone.

(7) Place auto throttle lever in engage position.

NOTE: If throttle levers move when auto throttle is engaged, set reference index on speed command indicator for no throttle movement.

(8) Manually move elevator trailing edge down. Throttle levers should move aft.

(9) When throttle levers stop moving, manually move elevator trailing edge up. Throttle levers should move forward.

(10) Move elevator trailing edge to neutral position.

(11) Place auto throttle lever in disengage position.

(12) Move all throttle levers to aft stops.

(13) Move gust lock control lever to lock position.

(14) Close following circuit breakers located on EPC circuit breaker panel:

(a) All engine start pump circuit breakers.

(b) All engine ignition circuit breakers.

AUTO THROTTLE CALIBRATOR - MAINTENANCE PRACTICES

1. General

A. The auto throttle calibrator is mounted on the front panel of the auto throttle computer/amplifier which is located in the radio rack. The calibrator is a plug-in unit and must be installed before the auto throttle system can be tested or put into operation. Corrective action consists of removal and replacement.

2. Removal/Installation Auto Throttle Calibrator

A. Remove Auto Throttle Calibrator

(1) Open auto throttle computer/amplifier circuit breaker, located on EPC circuit breaker panel.

WARNING: TAG AND SAFETY CIRCUIT BREAKER.

(2) Loosen attaching screws located at each corner of auto throttle calibrator.

(3) Carefully pull calibrator straight out from computer/amplifier, taking care not to damage pins at back of calibrator, or receptacle on front of computer/amplifier.

B. Install Auto Throttle Calibrator

(1) Make certain auto throttle computer/amplifier circuit breaker is opened, tagged, and safetied.

(2) Slide calibrator straight into front mounted electrical connector of computer/amplifier. Carefully apply firm pressure until electrical connector pins are properly engaged into receptacle of computer/ amplifier. Do not force fit. If mating is difficult, remove calibrator and check to see that no pins are bent or out of alignment.

(3) Tighten attaching screws located at each corner of calibrator.

(4) Close computer/amplifier circuit breaker.

3. Adjustment/Test Auto Throttle Calibrator

A. Test Auto Throttle Calibrator

(1) Depressurize hydraulic system (see Chapter 29).

(2) Open following circuit breakers:

(a) All fuel boost pumps

(b) All engine start pumps

(c) All ignition.

(3) Manually place all throttle levers to mid-quadrant position.

(4) With self test selector switch, located on computer/amplifier front panel, in off position, self test meter should indicate in red range (30 vdc power supply).

(5) Rotate selector switch to position 2.(A/S processor)

(6) Press and hold press to test switch located on computer/amplifier front panel. Meter should indicate in yellow range within 20 seconds.

NOTE: Auto throttle warning lights will come on when press to test switch is pressed.

(7) Release press to test switch. Rotate selector switch to off position.

(8) Return throttle levers to aft stop.

(9) Close circuit breakers opened in step (2).

CHAPTER 23

COMMUNICATIONS

CHAPTER

23

COMMUNICATIONS

CHAPTER

23

COMMUNICATIONS

1. Table of Contents Microfilm -- Instructions For Use

A. This microfilm contains the Table of Contents (TOC), and maintenance manual information for all DC-8 60 Series aircraft customers except Air Canada whose TOC reflects a combined 50/60 Series Maintenance Manual. For information on a specific aircraft, refer to TOC for the owner or lessee of that aircraft.

B. Each Table of Contents page has the Chapter, CODE, and Page number in the bottom outside corner of the page. The CODE number determines the customer; for example, CODE 1 is United Air Lines, CODE 2 Delta Air Lines and so on. The Table of Contents lists the Aircraft Identification page (if applicable), Alphabetical Index, and Chapter, Section, Subject matter with applicable aircraft CODE. Adjacent to the CODE, the aircraft effectivity is listed.

C. Aircraft are identified on the Table of Contents either by Effectivity Code Number, Fleet Number, Registration Number, or Factory Serial Number. The Factory Serial Number is used only when the Fleet Number or Registration Number is not available.

D. Table of Contents for all customers are listed immediately following these instructions. Where applicable, the Aircraft Identification page is inserted immediately following the TOC. This Aircraft Identification page contains the name of the customer or lessee, Manufacturing Series, Factory Serial Number, Effectivity Code or Fleet Number, and Registration Number. The Aircraft Identification page will have a customer CODE as described above.

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2. DC-8 60 SERIES AIRLINE CUSTOMERS -- TABLE OF CONTENTS INDEX

Customer Title	Airline Code	Table of Contents Code
United Air Lines, Inc.	UAL	1
Eastern Air Lines, Inc.	EAL	2
Swiss Air Transport Company, Ltd. Scandinavian Airlines System	SWA/SAS	3
Delta Air Lines, Inc.	DLT	4
National Airlines, Inc.	NAL	5
Braniff Airways, Inc. (was PAG)	BNF	6
Air Canada (was TCA)	AC	7
Alitalia-Linee Aeree Italiane	ALI	8
KLM-Royal Dutch Airlines	KLM	9
Trans International Airlines	TIA	10
Trans Caribbean Airways, Inc.	TRC	11
Canadian Pacific Air Lines, Ltd.	CPA	12
Saturn Airways, Inc.	STN	13
Union De Transports Aeriens	UTA	14
Japan Air Lines Co., Ltd.	JAL	15
Universal Airlines, Inc.	UNI	16
The Flying Tiger Line, Inc.	FTL	17
Capital Airways, Inc.	CAP	18
Iberia, Lineas Aereas de Espana, S.A.	IBR	19
Airlift International, Inc. (includes LYD)	ALF	20
Overseas National Airways, Inc.	ONA	21
Seaboard World Airlines, Inc.	SEA	22
Venezolana Internacional de Aviacion, S.A. (a/c included in KLM Contents)	VIA	23
Finnair-Aero O/Y	FIN	24
Luftverkehrsunternehmen Atlantis AG	ATL	27
American Flyers Airline Corporation	AFA	28
Air Afrique	AFQ	29
Air Congo	ACO	30

Chapter 23

TABLE OF CONTENTS

UNITED AIR LINES, INC.

Chapter 23

TABLE OF CONTENTS

EASTERN AIR LINES, INC.

Chapter 23

TABLE OF CONTENTS

SWISS AIR TRANSPORT COMPANY, LTD.

SCANDINAVIAN AIRLINES SYSTEM

Chapter 23

TABLE OF CONTENTS

DELTA AIR LINES, INC.

Chapter 23

TABLE OF CONTENTS

NATIONAL AIRLINES, INC.

Chapter 23

TABLE OF CONTENTS

BRANIFF AIRWAYS, INC.

Chapter 23

TABLE OF CONTENTS

AIR CANADA

Chapter 23

TABLE OF CONTENTS

ALITALIA-LINEE AEREE ITALIANE

Chapter 23

TABLE OF CONTENTS

KLM-ROYAL DUTCH AIRLINES

Chapter 23

TABLE OF CONTENTS

TRANS INTERNATIONAL AIRLINES

Chapter 23

TABLE OF CONTENTS

TRANS CARIBBEAN AIRWAYS, INC.

Chapter 23

TABLE OF CONTENTS

CANADIAN PACIFIC AIR LINES, LTD.